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INDIAN AGRICULTURAL
RESEARCH INSTITUTE, NEW DELHI

I.A.R.I.6.

GIP NLK—H-3 I.A.R.I.—10-5-55—15,000

Vol. I.]

1936.

[No. 2.]

AGRICULTURAL JOURNAL

*Issued by the
Department of Agriculture, Fiji.*

PRICE, ONE SHILLING.

27516



IARI

BY AUTHORITY. H. R. CRAIGIE, ACTING GOVERNMENT PRINTER, SUVA.

1936

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE
DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 1.]

SECOND QUARTER, 1928.

[No. 1.

EDITORIAL.

FOR some years the *Agricultural Circular* was published by the Agricultural Department and it met with a favourable reception among the planters of the Colony. It was discontinued pending a decision on the question of the formation of a semi-official Agricultural Society that would have issued a quarterly as its official organ. It was decided last year not to proceed with the formation of a Society and an amount was then placed on the Estimates for 1928 to enable a quarterly to be issued by the Department. The Estimates were not approved in sufficient time to enable a number to be issued for the first quarter of 1928 and this first number is therefore in respect of the second quarter and the first volume will contain three numbers only. The Editor hopes that the new publication will be as favourably received among the planting community as was the Circular and he will welcome any suggestions for its improvement.

The report of the Imperial Agricultural Research Conference held in London in 1927 has been received. This Conference marks an important step in the progress of agriculture within the Empire, and attention is invited particularly to a summary of the work accomplished by the Conference, by the Chairman of the Conference, the Rt. Hon. Lord Bledisloe, K.B.E., reprinted in this issue of the quarterly. It is interesting to note that the next Conference is to be held in Australia in 1932.

IMPERIAL AGRICULTURAL RESEARCH CONFERENCE, 1927.

GENERAL REVIEW OF THE WORK OF THE CONFERENCE.

(Speech by the Chairman, the Rt. Hon. Lord Bledisloe.)

You will expect from me, as your Chairman, some short summary of the results of our deliberations, so far as I have been able to visualize them, and I propose, with your approval, assembled as we are here on very historic premises which are the home of the Mother of Parliaments, to adopt what I believe for many generations has been, on such occasions as this, the usual Parliamentary practice, namely, to move, at the end of what I have to say: "That this Conference be now adjourned," and having made that motion to invite any of those present who desire to do so to offer any general remarks upon the utility of the Conference, upon the possible realisation of its ultimate aims and any suggestions, and this I say with the approval of the representatives of Australia, you may think fit to make with a view to the successful conduct of the next conference to be held five years hence in Australia. We are met here to-day to say good-bye; to wish each other Godspeed, and to express the hope that the seed which has this month been sown in what I think I may call well prepared ground may result in a rich harvest for the great Empire to which we are all proud to belong, and especially for its various agricultural communities.

This Conference has, in my judgment, been a great step forward with a view to the spread of ascertained knowledge to meet the needs of the Empire in relation to its most vital industry. It is, if I may say so, an important landmark in Imperial development, and is, I believe, a harbinger of great Imperial prosperity. It has been noteworthy for its comprehensively representative character; the eminence, if I may say so, of its personnel, both scientific and administrative; the unfailing high character of its discussions; the obvious keenness throughout its sittings, and its journeyings; and last, but not least, the unbroken harmony which has characterised its proceedings, and which has smoothed and sweetened them. The Conference has been a big experiment, and I claim for it that it has been an eminently successful one. Its main success, in my humble judgment, has been the mere fact of bringing together distinguished investigators in every branch of agricultural science and able administrators from every part and corner of the Empire, and the pleasant intercourse, friendship, and mutual confidence which have flowed from that simple fact. It may be asked, and no doubt the outside public in every part of the Empire will ask, what, in fact, it has achieved? Apart from the achievements implied in the important fact of its actual meeting, the tangible results may be said to be small, for the very obvious reason that it is not an executive body. It can only advise and recommend, and the carrying out of its recommendations depends, of course, upon the various Governments of the Empire. The majority of its results depend upon the co-operation of the various Governments and their willingness to act upon its recommendations.

What, then, has the Conference done to assist and advise executive Governments? We can point, at any rate, to three main results. In the first place it has surveyed the whole tropical and sub-tropical Empire as a field for agricultural research. It has recommended a scheme of central tropical and sub-tropical research stations. It has defined in general terms the needs which they are to meet; the character of their location and the scope of their work. It has removed some misconceptions as to the place and functions of a central research station in relation to the Government in whose area it is situated. It has made clear its relation to the teaching of agriculture, and it has indicated in a hopeful spirit the sources from which future contributions to central research stations might reasonably be expected. Moreover, it has discussed fully and made recommendations upon what I am sure you will all admit to be two subjects of vital importance to the Empire, namely, the establishment of a central research station in connection with diseases of animals and the further and immediate exploration of the question of a central research station to deal with irrigation.

Secondly, and it is perhaps the most important of all, it has surveyed the question of man power in relation to research. Research, after all, is a matter of individuals, and probably at no conference, no previous conference, has the question how to secure and train the best individuals for research work received more attention, or attention from persons more qualified to speak on the subject. The Conference has indicated the requirements which ought to be looked for in candidates both for specialized work and for posts as agricultural officers. It has fully reviewed the methods of recruitment and the inducements required to obtain efficient agricultural services in the tropical and sub-tropical parts of the Empire. In particular it has brought out clearly and made suggestions towards meeting the difficulty which arises from the predominance of the physical sciences over the biological sciences in almost, if not all educational institutions. It has similarly reviewed the training required for the Empire as a whole. It has considered and systema-

tized the best opinions on the highly important subjects of study, leave and interchange of workers.

It has examined in detail and, indeed, prepared plans for a considerable extension of the existing machinery for co-operation between research workers in different branches of agricultural science all over the Empire. It has by no means confined itself to pious aspirations. It has stated the actual subjects for which further machinery is to be set up, and it has indicated in some detail the nature, the place, and the character of that machinery. Three new bureaux and four correspondence centres will, it is confidently hoped, soon be displaying their vigour as flourishing children of this Conference.

The Conference was called largely to deal with these important administrative problems, but it has not confined itself wholly to their consideration. It would be, of course, utterly impossible to go through all the work which has been done, and most admirably done, and the recommendations which have been made by the various specialist committees. Many of those are covered by the administrative measures which the Conference has recommended. It is perhaps sufficient to say that practically every branch of agricultural science has been surveyed by those who are most familiar with it. Any gaps left in the provision now made have been indicated and recommendations have been made to fill them. One or two examples perhaps I may be allowed to give.

In plant pathology the Conference has drawn attention to the great importance of virus diseases in plants, and has made proposals for a more extended study of the fundamental nature of those diseases. It has pointed out the great importance of insecticides and fungicides in the control of diseases and pests, and has asked for an investigation of the whole chemical field by chemists working in collaboration with entomologists and plant pathologists. It has defined various important questions which urgently need scientific research, and the Conference, through its Veterinary Committee, has surveyed not only many purely technical or local problems in animal diseases, but also not a few which are common to practically all parts of the Empire, such as the elimination of tuberculosis and the methods of control and diagnosis of contagious abortion; and last, but not least, it has possibly for the first time endeavoured to make clear the value and vital importance of the study of agricultural economics.

Of course the results which are embodied in the Reports adopted by the Conference are very far from being all that the Conference has achieved. One result we in this country hope has followed and it will be peculiarly gratifying to us if that hope is fulfilled—is that the research workers from overseas have been afforded a chance, at the cost perhaps of a somewhat strenuous life, of seeing something of a good many of our research men and research stations in Great Britain and Northern Ireland. We hope that they are convinced that the research done there and the facilities which are afforded to the workers, both resident in this country and in other parts of the Empire, are such as to induce an ever-increasing flow of men coming here to learn and refresh themselves and also to instruct our own workers, just as we here realise the value and importance to a man habitually resident here of a visit, long or short, to another part of the Empire.

May I venture to say that, in my opinion, we have, as a result of this Conference, reached important decisions with an imposing measure of unanimity. We may, however, establish bureaux and chains of research stations, and we may train and exchange research workers, but without mutual confidence and the determination to co-operate which it engenders our task would be

in vain. The ultimate results of this Conference it is impossible to visualise and, in all their potentialities it would need a man of extraordinary courage and hypermetropic vision to prophesy the final dimensions of the new structure of which we have this month laid the foundation stone. At least that stone has, in my judgment, been well and truly laid. I have the temerity to believe that there has been no Conference of an Imperial character which has been more harmonious, more definite in its objectives, or more constructive in its deliberations and decisions; or, if I may be allowed to suggest it, more calculated in its results, not only to contribute to the ever-growing solidarity of the Empire, but materially to affect its future prosperity and happiness.

Agriculture we must remember is far the largest industry of the Empire, and for many generations yet will continue to be so. Upon its enhanced productivity as the result of the prudent application of science depends the well-being, the happiness and the contentment of the vast populations of that great commonwealth of nations to which we are all so proud to belong. On the 4th October we met as strangers. To-day we part, I think I may be allowed to say, as firm friends. May that friendship continue to grow for our mutual advantage!

You have thought fit to select as your new central scientific bureaux and correspondence centres certain research stations in this, the old country. Let me say on behalf of those stations that, in no insular or selfish spirit, we accept the Imperial trust which such selection involves and we shall endeavour to justify your confidence by the faithful discharge of our fiduciary obligations. The keen interest which our overseas colleagues have displayed in our own centres of agricultural research (and some of the most important of them still remain to be visited) has kindled the zeal of our British workers and our British administrators and has inspired us with fresh ideals and fresh determination to work earnestly in the cause of Empire development.

It is perhaps, gentlement, a little unfortunate that your visit has synchronized with a very exceptional, perhaps unprecedented, depression in agriculture in Great Britain, but I would like to say in that connection that, having worked in the field of agriculture both, perhaps for my sins, as a farmer and also in an administrative capacity for many years, I have a growing conviction that the fortunes of British agriculture lie very largely in the direction of realizing the Empire rather than this nation as the agricultural unit and the consciousness that by co-operation with due delimitation of our respective spheres with fellow agriculturists in other parts of the Empire there may be in store, even for British farmers, a larger measure of economic prosperity in the future.

We say good-bye to you, our overseas friends, with very deep regret, but the retrospect of our pleasant intercourse will always be happy and the prospect of its revival will be a stimulus in the pursuit of our daily avocations wherever they may be. The next Conference is destined to take place in Australia five years hence on the cordial and much appreciated invitation of the Prime Minister of that great overseas Dominion. We are especially glad to learn, by the message from the High Commissioner of New Zealand yesterday, that New Zealand is prepared to co-operate in making the Australian Conference a real success and has offered hospitality after the Conference to those delegates who are prepared to visit that beautiful and interesting part of the Empire. The last words I want to say are these. I do most confidently hope that we shall all do what is in our power to make the next Conference at least as great a success as this Conference has been. I realise—no-one can fail to realise—that there may be some attractiveness to those

who work in distant parts of the Empire to visit the old country from time to time, and to arrange their holidays, or leave, accordingly; but I do venture to hope not only that we who live and work in the old country will do our very utmost to get out to Australia and support the Australian Conference five years hence, but also that those who come from other parts of the Empire will do their very utmost and make up their minds now to set apart if they can a period for the Conference five years hence to visit Australia and to co-operate in making that occasion a big success.

With much regret I beg to move "That this Conference be now adjourned."

IMPORTATION OF NATIVE MATS INTO WESTERN SAMOA.

OWING to the presence of the Coconut Leaf Moth *Levuana iridescens* in this Colony the Government of Western Samoa prohibited the importation of mats, baskets, &c., from Fiji. Representations were made to the Samoan Government on the matter and as a result the importation of such articles is permitted provided they are accompanied by certificates of freedom from disease or have been subjected to fumigation or other treatment for the destruction of disease. Mats and baskets are subject to fumigation on arrival at Apia.

PINEAPPLE FIBRE.

At the request of Major Willoughby-Tottenham a small sample of pineapple fibre was recently forwarded to the Imperial Institute for examination and report. The Director of the Institute has furnished the following information:—

PINEAPPLE FIBRE FROM FIJI.

The sample of pineapple fibre which is the subject of this report was received at the Imperial Institute on the 2nd February, 1928, and is referred to in letter No. 1473/27 of the 21st December, 1927, from the Superintendent of Agriculture.

It was stated that the sample had been prepared from pineapple leaves by a local planter and it was desired to ascertain whether the fibre could be profitably marketed in the United Kingdom.

Description.—The sample weighed 9 ounces and consisted of two bundles of fine, fairly soft, lustrous fibre, varying in colour from pale brown to light green. The fibre, which had been well separated and cleaned, possessed good strength and had an average length of about 3 feet.

Results of examination.—A representative portion of the sample was submitted to chemical examination, and the results obtained are given in the following table in comparison with corresponding figures for samples of pineapple fibre previously examined at the Imperial Institute:—

	Present sample.	Pineapple fibre from		
		Malaya.	Sudan.	Gold Coast.
	per cent.	per cent.	per cent.	per cent.
Moisture	8.0	10.7	6.2	9.5
Ash	1.2	0.7	1.4	1.1
(a) Hydrolysis, loss	14.0	13.1	12.5	13.7
(b) Hydrolysis, loss	17.5	17.9	17.4	19.4
Acid purification, loss	3.2	2.9	2.3	1.7
Water washing, loss	2.0	2.3	1.2	..
Cellulose	82.7	78.6	82.4	81.5

(Calculated on moisture-free material.)

These results show that the present sample is similar in composition to pineapple fibre from other parts of the Empire.

The ultimate fibres of the material were found on examination to have the usual microscopical characters of pineapple fibre. Their lengths and diameters are shown below in comparison with figures previously recorded:

	Length in mms.			Diameter in mms.		
	max.	min.	mean.	max.	min.	mean.
Present sample	8.0	2.9	4.9	0.0127	0.0025	0.0063
Figures previously recorded	9.0	3.0	5.0	0.008	0.004	0.005

Remarks.—This pineapple fibre is of excellent quality, being generally well prepared and of satisfactory length. Consignments of similar fibre would be readily saleable in the United Kingdom and would probably realise at least £50 per ton at the present time.

Pineapple fibre is not a regular article of commerce in the United Kingdom, as it has usually been found that the cost of extracting it by hand is too high to make shipment profitable, and there does not at present appear to be any machine available which will do the work successfully. In the circumstances, it is suggested that information should be furnished to the Imperial Institute as to the quantity of fibre which could be produced annually in Fiji by the methods at present available in the Colony, and the lowest price which would make the export of the product remunerative.

INQUIRIES CONCERNING ESSENTIAL OILS.

THE following letter has been received from Messrs. Wilson & Mansfield which may be of interest to planters and exporters:—

“The Director, Department of Agriculture, Fiji.

“Dear Sir,

24th March, 1928.

“We have been making inquiries as to fresh sources of supply for Natural Essential Oils and allied products within the Empire, and seeing an exhibition of various Fijian products in the Museum of the Imperial Institute, from the Department of Agriculture, we take the liberty of writing you to ask you if any of the following are produced on a commercial scale in Fiji, and if so, would you be so good as to tell us how we could obtain the names of the producers or shippers. We would like to explain that we are importers and distributors of Essential Oils, &c., and have a regular demand not only here but in foreign countries.

“The following interest us particularly:—

“*Lemon Grass Oil.*—There is a steady demand for this oil, especially if it contains high percentage of citral to compete with that shipped from the island of Comore, the present price being about 3s. per lb to 3s. 3d. per lb c.i.f. packed in drums for oil testing not less than 75 per cent. citral.

“*Cinnamon Bark Oil.*—A small trade; prices from 2s. per ounce to 7s. according to grades.

“*Cinnamon Leaf Oil.*—A steady demand for oil with a eugenol content of not less than 88 per cent. similar to Seychelle variety.

“*Cardamom Oil.*—A very small trade. Practically all the oil used is distilled in Europe from imported Cardamoms; not worth considering.

“*Limes.*—We import lime-juice, raw and concentrated; also hand-pressed and distilled lime oils from the islands in the West Indies.

"If any one was interested in receiving information about the trade in these products we would write them fully.

"We also import from various parts of the Empire and foreign countries, or are otherwise interested in Vanilla beans in fairly large quantities:—

"Ginger root (dried), Tumeric, Cardamoms and other spices such as Nutmegs, Cinchona bark, Papain, Bay oil, and essences of lemon, orange and all kinds of Citrus fruits.

"We would like if possible to receive some particulars of oils of Macon and Dilo, as they are not known to us under these names.

"We would be pleased to supply any information regarding the market here or abroad for any article of produce, and value samples.

"Hoping that we may be of some service in this respect.

"We are, &c.,

"WILSON & MANSFIELD."

ENTOMOLOGICAL RECORDS.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

THE fruit fly *Dacus passifloræ* has recently been bred from cotton bolls (Kidney and Meade), grenadilla buds and pawpaw, all being fresh records for this pest.

The bug *Germalus pacificus*, Kirk, has been found abundantly in both nymph and adult stages feeding upon lantana berries.

The Pentatomid *Coleostichus sordidus* also feeds upon lantana berries, but only adults have so far been observed.

Several parasites have been reared from the Pink Roll worm *Platyedra gossypiella*. Amongst these an, as yet, unnamed Chalcid was found to be destroying 15 per cent. of the pupæ at the Cotton Experimental Station at Sigatoka.

The cotton pests *Dysdercus insularis*, St., and *Tectocoris lineola*, F., were both found feeding upon the fruits of an unidentified species of *Sterculia* on Ovalau. The *Dysdercus* was in great numbers.

PROGRESS REPORT ON THE COCCINELLIDAE IMPORTED FROM TRINIDAD TO CONTROL ASPIDIOTUS DESTRUCTOR.

By T. H. C. TAYLOR, Assistant Entomologist.

1. *Species introduced*.—Five species were landed in Fiji on 6th March. These were:—

(1) <i>Cryptognatha nodiceps</i> , Mshl.	1,517
(2) <i>Azya trinitatis</i> , Mshl.	162
(3) <i>Pentilia insidiosa</i> , Muls.	22
(4) "Spotted" sp. (unidentified)	69
(5) "Small" sp. (unidentified)	400

The figures indicate the numbers landed alive in the Trinidad cages.

2. *Preliminary attempts at breeding in Fiji.*—Although the numbers landed were small in some cases they would have been ample for breeding purposes had the conditions prevailing in Fiji been the same as those in Trinidad. With the exception of *C. nodiceps*, however, none of the species bred satisfactorily.

It is possible that the very wet, cold weather which prevailed during April partially accounted for the failure of these species; but the fact that they bred satisfactorily during the voyage from Trinidad, in spite of the very adverse conditions (notably, extreme heat, great humidity and partial darkness) to which they were at times unavoidably subjected, testifies to their hardihood and makes it improbable that climatic conditions in Fiji were in any way responsible for their failure.

All the species except (1) were heavily attacked by ants in the Fiji cages, and there is no doubt that ants were the chief cause of the failure. Species (3), (4) and (5) were almost wiped out by them. Ants have been observed attacking and carrying off living larvæ and pupæ of these three species. This difficulty was largely overcome by tanglefooting the cages and varas, but in the meantime the stock of beetles had become so depleted in all species except *C. nodiceps* that it was considered too risky to leave the few remaining adults in the cages. We therefore decided to attempt breeding in tubes in order that closer watch might be kept on all individuals and ants completely excluded. Tube-breeding has presented many difficulties however, and although it saved the situation, we now have no more individuals of species (2), (3) and (5) than we had on 6th March.

It is almost certain that *C. nodiceps* is also attacked by ants, but we have come to the conclusion that its success, in spite of ants, is due to the fact that it has been present from the first in much larger numbers than the others, so that the number destroyed by ants is negligible by comparison. Further, the life cycle of this species is shorter, and its rate of multiplication therefore greater than any of the others; hence it is better able to withstand the attacks of ants.

3. *Cryptognatha nodiceps.*—Tube breeding proved satisfactory for this species, but is unnecessary. It multiplies so rapidly in the cages that we sometimes have great difficulty in maintaining a sufficient supply of scale, but the chief difficulty arises through its very strong cannibalistic tendencies, even when an abundant supply of scale is present.

Two colonies of *C. nodiceps* have already been liberated, and we hope to have sufficient adults (about 1,000) for three more colonies a fortnight hence.

4. *Azya trinitatis.*—This species has been very disappointing. In Trinidad, except for *C. nodiceps*, this is the most efficient species, yet in Fiji it will scarcely breed at all; and although ants have been troublesome at times they are now completely excluded. We cannot yet explain the failure of *Azya* satisfactorily. It will not oviposit in tubes, and even in the cages very few eggs are laid. Many larvæ die for no apparent reason, and those which survive grow extremely slowly. On the ship it bred well in the cages without much attention, even when the food supply ran short, and its failure in Fiji is therefore all the more puzzling. The most satisfactory method of breeding it seems to be to enclose the adults in thin cloth bags over varas, an alternative measure which was adopted with great success for all species on the ship. The only explanation which we can offer for the failure of *Azya* is that there is some difference between the scale in Fiji and that in Trinidad.

5. *Pentilia insidiosa.*—Adults lay well in tubes, but the majority of the eggs obtained in this way were killed by mildew on the strips of leaf on which

they were laid. This difficulty has now been overcome, but the stock has become very low in the meantime. It will be necessary to continue breeding in the tubes for another month at least, and no adults will be available for liberation for at least two months.

6. "*Spotted*" *sp.*—This species is promising. Much difficulty was experienced with it at first owing to ants, but it laid well in tubes, and by means of tube-breeding we have been able to obtain sufficient numbers to put in a cage, where it is now breeding very well. It is probably unwise to liberate this species until about 400 adults are available and this will not be for another month or more.

7. "*Small*" *sp.*—This species is particularly liable to be attacked by ants, and it is the only one which is attacked by them in the adult stage as well as in the early stages. At present, tube-breeding, which proves satisfactory, must be continued. One colony was liberated on Wakaya in March, but there will not be sufficient adults for further colonies for some time yet.

8. *Liberations.*—Colonies have been liberated as follows:—

C. nodiceps.—(1) 500 at Koro Levu, Wakaya, on 10th March by

R. W. Paine; (2) 400 at Garani, Gau, on 2nd April by T. H. Taylor.

"*Small*" *sp.*—(1) 100 at Koro Levu on 10th March by R. W. Paine

We are of the opinion that it is unwise to liberate less than 400 adults at any one time. A study of the habits of the adults indicates that the best time to liberate them is from a week to a fortnight after they emerge.

9. *Reports from Wakaya.*—On 10th April we received a letter from Mr. de Mouncey saying that the tree on which *C. nodiceps* was liberated at Wakaya had "hundreds on." They evidently had just completed one generation. On 3rd May we received a further report from Mr. Hunt, of Wakaya, who said that the tree was absolutely covered with "white bugs with many long legs." We showed him the larvæ of *C. nodiceps* and he said they were certainly the same as the "many-legged" creatures. We believe these reports to be sufficiently reliable, and therefore feel fairly confident that *C. nodiceps* has become established on Wakaya.

10. *Relative importance of the five species.*—We are now in a position to estimate the relative importance of the five species in Fiji. The order of importance in Fiji as compared with that in Trinidad is probably as follows:

Fiji.		Trinidad.	
(1) <i>C. nodiceps.</i>	....	<i>C. nodiceps.</i>	
(2) " <i>Spotted</i> " <i>sp.</i>	....	<i>A. trinitatis.</i>	
(3) <i>P. insidiosa.</i>	....	<i>P. insidiosa.</i>	
(4) " <i>Small</i> " <i>sp.</i>	....	"<i>Small</i> " <i>sp.</i>	
(5) <i>A. trinitatis.</i>	....	"<i>Spotted</i> " <i>sp.</i>	

It now seems very probable that *C. nodiceps* alone will do all that can be done to control the scale by natural means in Fiji, and even if the other four species also become established we are inclined to doubt whether their presence will materially increase the control. We propose to continue breeding the others if possible, but should one or more of them die out we think it would make no difference to the ultimate result. Certainly the prospects in the case of *C. nodiceps* are very good.

11. *Scale supply.*—There is, as usual, much difficulty in maintaining a sufficient supply of scale. The present generation of *C. nodiceps* alone has consumed all the scale on 35 large varas, all of which were absolutely covered with it two weeks ago. We are now satisfactorily supplementing the food-supply with scale from mango trees and baringtonia. Scale is still available

on the coconuts beyond Cawaci. In view of the comparatively plentiful food supply present on Ovalau it seems desirable to continue to make Levuka the centre for this work.

12. *Life-history work*.—We are making careful observations on the bionomics of these *Coccinellids* and hope within a month or so to have fairly complete records of the life-histories of at least three species.

13. *Elimination of natural enemies*.—Two internal parasites, *Tripolycystus cryptognathæ* and "Coccinellid Parasite II," were found abundantly in Trinidad attacking *C. nodiceps*, *A. trinitatis*, *P. insidiosa* and "Small" sp., and every precaution was taken, both in Trinidad and during the voyage, to eliminate these parasites. Neither of them appeared on the boat from Panama to Fiji, nor after the cages were landed in Fiji, and it is certain that both were completely eliminated. This should materially increase the effect of the *Coccinellids* in Fiji, as compared with Trinidad.

14. *Conclusions*.—

1. The Trinidad *Coccinellids*, considered together, promise well.
2. *C. nodiceps* is almost certainly established in Fiji.
3. *C. nodiceps* is certainly the most promising.
4. Satisfactory methods of breeding all the species, except *A. trinitatis*, have now been evolved.

STAINED COTTON IN FIJI AND ITS CAUSES.

By H. W. SIMMONDS, F.E.S., Government Entomologist, Fiji.

THERE are in Fiji two types of stained cotton which are of major importance, and which have both caused considerable loss to growers. The first of these shows as a reddish brown discolouration of the lint, commencing at the point on the seed which lies closest to the husk of the boll and spreading in a fan-like manner along the lint fibres. This stain is most in evidence early in the season and, whilst not nearly so abundant as the yellow stain to be described next, caused some anxiety at one time, as it was, in England, supposed to be due to the accidental presence of mineral oil. I found, however, that the bug *Tectocoris lineola*, when not infected by having fed upon diseased material, produced this stain freely in my breeding cages. It seems to be of a mechanical nature, only being produced when no infection is introduced at the time that the seed is punctured by the insect when feeding.

The second and far more abundant type of stain is of almost world-wide distribution, and depends upon the attacks of the various cotton stainers of the genus *Dysdercus* for its distribution. This stain is of a very pale yellowish nature, and is generally diffused over the whole area of the affected section of the boll, not starting from a definite point on the seed as the former does. Early pickings suffer very little from the trouble, but as the season advances, it becomes increasingly abundant, causing very heavy depreciation in the value of the crop.

EXPERIMENTS.

During 1927 a number of experiments were carried out with the Fijian cotton stainer *Dysdercus insularis*, to test the effects of its attacks upon bolls and flower buds, and these are detailed below.

First Experiment.—On May 20th twelve second instar nymphs of this species, which were nearly ready to enter their third stage, were placed,

two and two, into six calico-covered wire cages. The cages were supported on wire rings hung on sticks, and each placed over a flowering shoot of Sea Island cotton. They were inspected from time to time, the growth of the enclosed insects being found to be very slow.

On June 14th all were examined, when it was found that there had been a considerable shedding of flower squares (some 50 per cent.). The enclosed bolls were then cut open and carefully gone over with a lens. No trace of puncture or proliferation was found, and it seems certain that up to the end of the third instar the nymphs are unable to puncture the bolls, but obtain their nourishment from the surface layers of the plant and flower squares, causing some loss of flower buds. In the cages the growth of the enclosed nymphs was very slow, doubtless because, being unable to wander over the plant, they found it difficult to obtain sufficient food in a suitable stage of growth and were partially starved.

On this date (June 14th) only one of these nymphs had entered its fourth instar, whilst the remainder of the brood from which they had been taken, and which had been fed upon young extracted cotton seed, had all entered their fifth instar from two to four days.

Second Experiment (June 14th).—Four specimens of fifth instar nymphs were next placed in two cages to see if, at this stage, they were capable of puncturing the bolls and the effects of such punctures upon the lint. The cages were examined on June 27th, when it was found that in one cage all the bolls except one had fallen off. This one had been heavily punctured and the seeds were rotting. No yellow stain was, however, present. In the second cage one boll was examined and found to be punctured, with typical proliferation. The remaining two bolls were then left to mature in order to observe if any stain was produced; none, however, occurred. It was then decided to commence a fresh set of experiments to check the above, leaving the bolls to mature in each case. These are detailed as follows:—

Third Series.

Bag No.	No. of specimens.	Stage of nymphs.	Date.	Results.
1	2	Second instar	9/7/27	Neither puncture nor proliferation.
2	6	Fourth instar	3/9/27	Proliferation but no stain.
3	6	Third instar	8/8/27	Little growth, no puncture or proliferation.
3	1	Fourth instar	15/8/27	Proliferation but no stain.
4	5	Fourth & fifth instar .	11/8/27	Bolls aborted and dropped off.
5	6	Fifth instar	16/8/27	One boll damaged but no stain.
6	4	Fifth instar	25/8/27	Proliferation but no stain.
7	3	Adult	30/8/27	Proliferation but no stain.

In the above experiments all the nymphs and adults used had been reared in captivity from the egg and fed upon clean immature cotton. It will be observed that in no case did second or third stage nymphs produce punctures, but that from the fourth instar onwards punctures, with the accompanying proliferation, were general, but in no case was the typical yellow stain obtained. In two instances, however, rots were introduced and these were also met with in the previous *Tectocoris* experiments.

Laycock in Nigeria (R.A.E. Vol. 4, p. 320) shows that the yellow stain is due to introduced fungus, and the above confirms his results. Laycock, however, found his non-infected nymphs produced a brown stain, apparently similar to that which I obtained from *Tectocoris*. I have, as yet, obtained

no stain of this type from *Dysdercus* in Fiji, and it is possible that our species is of a feebler type and mechanically incapable of producing it.

The experiments carried out this year show that:—

1. The brown stain is produced by *Tectocoris lineola* and is apparently mechanical, being produced freely by insects reared under cover in captivity.

2. That although punctures of the bolls and proliferation take place freely, when fourth to adult stage *Dysdercus* feed upon cotton, no stain is produced upon the lint as a result of such feeding when clean fed *Dysdercus* are used, and that the yellow stain, as also many of the cases of rotting and aborting of the bolls, is due to the introduction of fungus spores by the insects when feeding, after having previously fed upon diseased bolls.

THE HOUSE FLY PROBLEM IN FIJI.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

INTRODUCTION.

EARLY verbal accounts bear witness that house-flies were at one time very troublesome throughout Fiji. These verbal accounts are supported by the following extracts from P. H. Bahr's *Dysentery in Fiji in the year 1910*:—

Page 22.—“House-flies (*Musca domestica*) constitute a great plague in Fiji. They swarm during the hot weather (November to April) in Suva; in the sugar districts they are prevalent throughout the year.”

Page 23.—“The phenomenal preponderance of flies in Fiji, the great frequency of dysentery there, the concurrence of the fly season with the dysentery season . . . are distinctly in favour of regarding Fijian epidemic dysentery as a fly-borne disease.”

Page 9.—“The abolition of epidemic dysentery in a town of the size and importance of Suva depends upon an efficient sanitation, mainly directed against the house-fly.”

About the year 1912 on Vanualevu and somewhat earlier on Vitilevu there was, in many parts however, a great improvement in the position regarding this pest. This improvement was attributed to the work of a small brown ant, *Pheidole megacephala*. The observations on the subject, which were first made by Professor Illingworth, are reported in the Annual Report, Department of Agriculture, Fiji, 1914, page 24; and have been amply confirmed by myself, on many occasions since, at the stables of Messrs. Robinson & Ballantyne.

Despite the improved position in certain parts, however, flies continued to be numerous, and even a plague, in other parts of the Group, notably the Rewa Valley, when, in November, 1919, they actually blackened the ceiling of the dining room of one house I stayed at. Another bad place was (in 1921) Malolo Island and also Taveuni. In Suva the incidence of the pest varies greatly, not only in different seasons, but also in different parts of the town. One of the worst areas is Circular Road, regarding which complaints were made as far back as 1916. Investigations were carried out at that time by the Medical Officer of Health and the Government Entomologist (Mr. F. P. Jepson) when it was supposed that the Chinese gardeners, who used stable manure, brought about the outbreaks (Ann. Rep. Dept. Agric., Fiji, 1916, p. 22). In 1921 further complaints regarding this district were investigated by Dr. Carment (then Medical Officer of Health) and myself. The stable manure dumps, Chinese latrines, cow dung and refuse heaps were examined, without however any definite results. The stable manure used by the gardeners came from Messrs. Robinson & Ballantyne's stables and,

when in the bins, was found to be full of larvae, so that, although neither pupae nor larvae could be found in the dumps in the gardens, this material still remained under suspicion as the origin of the trouble. Now, however, the Chinese gardens have gone, but the flies still remain as troublesome as ever. They are also very troublesome in certain other parts, well removed from stables or stable manure.

At the time of the earlier investigations, and until quite recently, the common Fijian house-fly was supposed to be *Musca domestica*, a species which normally does not breed in cow dung. The common Fijian fly is, however, undoubtedly a different species the name of which is still uncertain. It has somewhat different habits and, as will be shown later on, is now found to breed normally in cow dung.

HOUSE-FLY INVESTIGATIONS IN 1928.

In consequence of the large numbers of flies present towards the end of 1927, I again decided to carefully search cow dung, to see if I could locate where they were breeding. In this search I was successful, finding, on January 22nd, maggots in vast numbers in dung of a certain age, mostly in the lower layers. The first of the adult flies from these maggots emerged on January 29th, and proved to be the common house-fly of Suva.

In order to be certain that this was so, I decided to take a count of flies in my own house, which, adjoining a cow paddock, is much troubled by the pests. I therefore closed the house and, using "fly-tox," collected all flies which fell. I also cleaned out the kitchen and collected, with a net, those present on the benches and lines. Seventy-seven flies were collected in this way and seventy-one, or 92.22 per cent., proved to be this cow dung breeding species. In view of this discovery a series of observations and experiments were made to try to trace the incidence, habits, life history and also other breeding grounds of this pest. These observations are recorded below.

FIELD AND LABORATORY OBSERVATIONS ON BREEDING HABITS AND LIFE HISTORY OF HOUSE-FLIES IN SUVA.

Cow dung was examined in the following localities:—Circular Road, Suva (frequently); Mr. Martin's paddock, Gorrie Street, Suva (several times); Golf Links, Suva; Reclamation, Suva; Wainibokasi River, Suva; Miss Rennie's paddock near Girls' School, Suva. At all of these places fly maggots were found in great numbers, and less frequently, pupae were also discovered. These latter were sometimes present in the drying cakes of dung, at other times in the soil beneath and amongst the surrounding grass roots, whilst on one occasion two were found in some old horse manure adjoining a cow dropping. Weather conditions must have a considerable influence in deciding where the larvae pupate, as also they must determine when the adults can oviposit and, at times, entirely prevent this latter taking place. Undoubtedly there are times when, either directly from this cause, or indirectly from its effect upon the mechanical nature of the crust of the dung, fly maggots are difficult or impossible to find, yet a few days later vast numbers will be present in the same paddock. This is probably the reason why neither the Medical Officer of Health nor myself located, in cow dung, the origin of the pest in Suva when working on this subject in 1921–22.

I find that this fly seldom (if ever) oviposits upon droppings lying in shade. I do not think this is due to the shade directly as such, but, rather, to the slow formation of the crust which does not reach a suitable stage until the whole nature of the dropping has undergone changes rendering it unsuitable to the fly's purpose. The normal habit of the fly seems to be to

oviposit upon droppings of four up to, perhaps, 24 hours of age, which lie in the open, when the droppings have formed a thin, leathery crust, but are still quite soft and fresh beneath. The flies oviposit equally in bright sunshine or dull warm weather, but not in rain.

Egg stage.—The eggs are deposited in the natural folds and pockets formed in this crust in drying, and are laid, a number together in little heaps. As with the European house-fly, *Musca domestica*, there is a marked tendency for a number of females to oviposit close together in the same pocket. On February 3rd flies were observed ovipositing in cow dung in Circular Road between the hours of 10 and 11 a.m. The day was sunny, with a strong south-east wind following rain. The droppings selected were lying in the hot sunshine and I estimated them at the time to be about 24 hours old. In the light of further observations I am of opinion that that estimate was too long and that they were somewhere between six and 12 hours of age. A number of batches of eggs were collected and taken home and the droppings marked for daily observation. The eggs, which were taken home, commenced to hatch at 7 p.m. and had all done so and entered the dung by 9 p.m. The temperature ranged from a maximum of 86° Fahr. to a minimum of about 74° Fahr. at the time of hatching. This gives an incubation period of about nine hours at the above temperature.

Larval stage.—The droppings were examined each day and it was found that the development period of the larvae was surprisingly slow. On the third day they appeared to be barely half grown, on the sixth, however, some of them seemed to have disappeared, presumably having entered the soil to pupate, as a solitary, newly turned, pupa was found just below the dropping.* On the seventh day there were still a very large number of the maggots which had not entered the soil, but the majority of these had done so by the next day, a few however remained until yet another day, being ten days from when ovipositing was observed to be taking place.

Check experiment in laboratory.—A number of eggs from the same dropping and of the same date (February 3rd) were brought away to rear in the laboratory as a check on the field observations. None of these had pupated on the 11th (eighth day), but the majority had entered the soil in preparation. A few however were still in the larval stage on the 12th and some of these had not pupated even on the 15th.† Food shortage may, however, have influenced these latter. The above gives a period of 5½ to 8 or even more days for the duration of the larval stage, with the majority pupating about the eighth day, the weather being cool to average summer weather. Just before pupating it was observed that the larvae had become a clear cream colour due to the absence of food in the alimentary canal. In a second laboratory batch, with abundant food, the first pupation occurred about 6 days 20 hours after the eggs were laid, the balance pupating within the next 23 hours, thus giving a larval period of 6 days 11 hours to 7 days 11 hours.‡

Pupal period.—Digging beneath and around the droppings in the field led to a considerable number of pupae being found. These lay from one

* There is of course a possibility that this pupa did not belong to this batch, but it is unlikely.

† These however all failed to mature.

‡ A large number of this brood completed their cycle from egg to adult in a shade under 12 days. The weather was particularly warm and humid, with a mean maximum for the twelve days of 87·5° F. and a mean minimum of 76·16° F. and an actual maximum of 91° and a minimum of 74°. These temperatures are high, even for the Fijian summer and will sufficiently account for this rather shorter life cycle. For fuller details see Appendix B.

to three inches into the soil, very frequently in the roots of grass, whilst sometimes a number would be found in the dropping itself. Judging by the numbers I was able to find I think the larve must often travel some considerable distance in search of a suitable pupating site. None of the pupae found in the field have as yet proved to be parasitised.

Length of pupal period.—This was also longer than expected and, in the moderate summer weather experienced this season, averaged about six days.

Length of life cycle.—The times for the life cycle work out as follows:—

Incubation period	9 hours.
Larval period	5½ to 8 or even more days.
Pupal period	5½ to 6½ days.

To this must be added the time which elapses between when the fly emerges and the time that it is ready to oviposit. This is uncertain, as I have not yet been able to observe pairing in captivity, although various methods to bring it about have been tried. My bred flies may have paired in the big cage or in the cylinders before being put into the breeding cage. The average period probably lies between three and seven days. This gives a total of fourteen to twenty-one days from egg to egg, which period will probably be found to be even longer in winter.

It is the larval portion of this cycle which is surprisingly long and this may be the important factor affecting the number of flies present, from time to time, in houses. In so long a period it must at times happen that the medium, in which they are feeding, dries out before they have reached maturity or gets washed away in heavy rains. It is also a factor which should assist in any scheme for reducing the pest.

Some idea of the number of flies which can emanate from a cow paddock can be gained from the flies which resulted from the eggs brought away for observation on February 3rd. These yielded 108 adults on the 17th, 190 on the 18th, 68 on the 20th, a total of 366 flies in three days with still more to come at time of writing. These eggs all came from one dropping and did not represent one quarter of the maggots present, which must sometimes run into two thousand in a single dropping.

OTHER INSECTS PRESENT IN COW DUNG.

In addition to the common house fly there are, in Fiji, several other insects which breed in, or about, or haunt cow dung. The commonest of these is the larva of a large *Sarcophagid*, which is very abundant. The adult fly is of filthy habits and is given to entering houses. I bred a large number of a small black *Anthomyid* on one occasion and have also taken this fly in the office. A tiny *Phorid* is abundant, whilst there are a few beetles of the *Aphodiinæ* group generally present. A *Staphelinid* beetle, occasionally observed, may be of use as a predator, but is not numerous enough to be of any practical value. No parasites were bred from pupae collected from cow dung, although *Spalangia* sp. (?) was bred from pupae from horse manure. Most of these were bred from *Stomoxys* pupae. I have, as yet, not found them in the open, in either *Stomoxys* or *Musca*, but both *Musca* and *Stomoxys* were attacked in the stables. When bred through in the laboratory this parasite took from 18 to 22 days from egg to adult, using the cow dung *Musca* as host.

OTHER SOURCES OF FLIES IN SUVA.

Search was made to see if any other considerable source of flies occurred in Suva, and such a source was found in the city dump. This was visited in company with Mr. Ellis on January 12th. Flies were observed settled

in swarms upon the surface, whilst the top layers were found to contain great numbers of maggots of several kinds, including *Muscids* and *Sarco-phagids*. A number of the former were collected to breed out. These proved to be the same species as bred from cow dung. The area in which the maggots occurred only descended some three or four inches, below which fermentation was taking place, with a temperature too high for the maggots to endure. Comparatively few pupae were found and it is possible that, in this case, there may be considerable mortality at the pupation period.

At this dump the method of disposal of the refuse is to spread it in a fairly thick layer, subsequently covering it with sawdust and grass. As soon as dry enough this is burnt, and it is a considerable time (six weeks) before another layer is placed over it. It was found that burning did not destroy the maggots or render the material unfit for their breeding. Maggots were apparently just as numerous in the freshly burnt area as elsewhere and from that point of view the method is a failure. I am of opinion that if the material were placed in a somewhat thicker layer (so as to reduce the surface area and increase the rapidity of fermentation) and a fresh layer placed over it within eight days, fermentation would destroy large numbers of the maggots, whilst if the surface layers could be turned under just before the new layer was placed on it, such destruction would be very effective. With the completion of the destructor the dump, as a source of flies should, however, disappear.

Horse dung.—Surprisingly few fly larvae were found in the stable bins in Suva, a great improvement on 1921 being observed. This is probably largely due to the use of wood chips instead of straw or sawdust for bedding, as similar results have been obtained in Europe by using shavings or peat instead of straw (B.M. Economic Series No. 1A, page 17).

In all, 77 pupae were collected from stables, and these produced 28 *Stomoxys calcitrans*, and 37 of a *Muscid*, which I am unable to separate from the cow dung species, although a few are somewhat smaller. There were also 12 specimens of a *Spalangia* pupal parasite. These came mostly from Burns, Philp's stables, where the parasitic percentage was over 50 per cent. Horse droppings in the field have also been examined, but only on one occasion have *Muscid* larvae been found and then only two. Ants, *Pheidole megacephala*, swarm over the droppings, and in the stables I have frequently seen them removing eggs and small larvae and they probably account for the absence of larvae from this medium. Cow dung is of very different texture, the eggs are laid whilst the surface is probably too soft for ants to hunt over it and, once hatched, the larvae must be absolutely protected from these predators in the soft semi-liquid interior.

Grass cuttings.—Complaints had also been received of the presence of biting flies *Stomoxys* on the cricket ground and neighbourhood, and it seemed probably that grass cuttings deposited along the sides of the grounds were the source of this pest. These cuttings were therefore examined and it was then found that conditions varied very considerably in different dumps. A certain number of pupae and maggots were found in one or two dumps where the cuttings were damp, rotting and cool, having been deposited in a thin layer and in a damp spot. Where deposited in a thick mass and dry, fermentation was keeping the temperature too high for maggots to endure. It is however possible that in wet weather there may be a layer of these thicker heaps, sufficiently moist and cool for the fly's purpose. Chicken were however working over the heaps and must greatly reduce any flies arising from this source. Of the pupae taken away all proved to be, as expected, *Stomoxys calcitrans*. These pupae were collected 31/1/28 and the

emergences occurred on the 2nd February (1 fly), 3rd (2 flies), 4th (1 fly) and sixth (3 flies), so that the pupal period of this fly may also be as long as six days.

Another examination was made on the 9th February, when neither larvae nor pupae could be found. Further material was however collected at a later date, which also proved to be all *Stomoxys*. No parasites were bred out of any of this material.

FLIES FREQUENTING HOUSES IN SUVA.

In order to confirm my former experience further counts were made of flies in my kitchen. These were made on the 13th January and 24th of the same month. On the 13th some 85 specimens were obtained, 28 being males and 62 females, whilst on the 24th a further 107 were captured, of which 57 were males and 50 females. Subject to examination by a specialist all appear to be the same species as the one I have found breeding in cow dung, the name of which must remain open until definitely identified. A few *Sarcophagids* have also been observed in the house, whilst at the office, *Stomoxys calcitrans* was decidedly in evidence. All the *Sarcophagids* taken seem to be the cow dung breeding species, which is particularly filthy in its adult habits.

HABITS OF THE COW DUNG HOUSE-FLY AND ITS RELATION TO HUMAN FÆCES.

I have shown that this cow dung breeding fly is the common species found in houses in Suva. Its habit is to crawl over plates, spoons, &c., and it is particularly given to sitting on the portion of a cup or glass where anyone has been drinking. It feeds greedily upon sugar, bread, jams and chutney, and leaves its vomit and fæces wherever it settles. It is a thirsty fly and settles on the lips of milk or water jugs for the drops of liquid that lie there when in use.

It is not only a most annoying pest of human beings, being of a particularly persistent and sticky nature, but it is given to settling upon skin wounds of any kind and the lips of small children, with serious risk of carrying infection. On a visit to the Waimanu Road, Suva, where there is often a good deal of Indian expectoration, I observed that the sputum was in each case surrounded by a circle of flies feeding upon it, all of which appeared to be this same species.* I have also observed this same fly upon the fæces of birds and animals, upon human vomit and the discharge of a boil (human). As its relation to human diseases is much bound up in the question whether or not it feeds upon, or breeds in, human fæces, a number of experiments and observations were made to determine its habits in that respect. These investigations were carried out along the following lines:—

Experiment No. 1.—Visits were paid, in company with Dr. Bailey, to the Indian and Chinese latrines about Flagstaff Hill on January 17th and 20th. I found the latrines were kept wonderfully clean and every care taken to minimise danger from this source. Nevertheless flies were practically universally present, although seldom numerous. In the confined space of the latrines they were difficult to catch, but some 27 examples were taken. One of these has been tentatively identified for me by the Superintendent of Agriculture, as *Synthesiomyia braziliensis*, the remaining 26 all appearing to be the cow dung breeding, house haunting species. The flies were

* I have only been able to confirm this observation on one or two occasions since and the attractiveness of the expectoration probably varies according to its contents, or possibly, atmospheric conditions.

observed settled upon the seats, the sides of the pans, and particularly upon the floors, if any liquid, such as urine, had been spilt there. In these latrines a *Sarcophagid* was observed a number of times but in the confined space I was unable to capture any, so cannot be sure as to the species. There is, however, little doubt that it is the cow dung species, as this fly is generally the first attracted by human fæces.

Experiment No. 2.—In the next test human fæces were exposed in the scrub. On this occasion it was found that *Sarcophagidae*, *Trypetidae* and *Ortaliidae* were the flies usually present and no *Muscid* was observed. This experiment was repeated with similar results.

Experiment No. 3.—In the next experiment a group of newly emerged flies, bred from cow dung, were placed in a glass jar and offered cotton wool soaked in honey and water, also pieces of cork with a thin film of human fæces spread upon them. Both were visited by the flies, but they showed a marked preference for the fæces to the extent of at least two to one. The flies were observed to feed upon it and the small drop of saliva which they secrete, in feeding, was distinctly visible. This experiment was repeated a number of times with similar results.

Experiment No. 4.—The most important test was, however, to see whether this fly would breed in human fæces. For this purpose two batches of flies were taken, which had emerged from cow dung on the 30th January and on the 1st February respectively. These were fed upon honey and water until the 6th February, pairing not being observed. At 10 a.m. on February 6th these flies were placed into a large cage which also contained a tin of freshly voided human fæces. Honey and water were supplied for food and the cage visited from time to time, when the following observations were made:—

Date and time.				No. of flies on fæces.	No. of flies on sides of tin.	No. of flies on honey and water.
Feb. 6—10.10	a.m.	..	..	2	.	.
..	10.30	..	..	2	.	.
..	11.45	..	..	1	.	.
..	12.10	..	..	1	.	.
..	1	p.m.	..	7	3	.
..	2	..	..	6	.	.
..	2.45	..	..	9	.	.
..	3.30	..	..	2	3	.

During this first day the fæces were apparently visited for food only, examination on the morning of the 7th showing no eggs.

Feb. 7—9	a.m.	..	..	4	1	.
..	7 noon	..	..	5*	.	.
..	7 2 p.m.	..	..	5	.	3

* All apparently ovipositing, fæces had begun to harden.

By their going to the honey it seemed possible that they might be thirsty, so the cage was sprayed with water.

Feb. 7	3.30 p.m.	..	..	6	.	.
..	8 8.40 a.m.	..	..	7	.	.
(away rest of day.)						

Feb. 9, 11.30 a.m.—The fæces were examined and found to full of small maggots and a number of batches of hatched eggs observed. These had apparently all been deposited on the 7th.

Feb. 10.—Fæces removed from tin and placed into a pan with soil and moistened.

Feb. 15.—The majority had entered the soil to pupate at 9 a.m., a few of the pupae being found at 3 p.m. The great mass however did not pupate until the night of the 16th/17th and morning of 17th.

The larvae thus took nearly eight days from egg to pupa as a minimum. Food shortage may have prolonged it slightly but I do not think so, as it approximates very closely to those bred in cow dung, whilst the pupæ were mostly of full size, as also were the adult flies, when they emerged. The first of these adults emerged on the night of the 19th/20th, 12 males and 10 females up to noon, *i.e.*, 13 days from the time the eggs were laid, whilst the majority emerged on the 22nd and 23rd. The pupal period was carefully checked and worked out at $5\frac{3}{4}$ to $6\frac{1}{4}$ days (see Appendix B).

SUMMARY.

It is now certain that the principal source of house flies in Vitilevu is cow droppings as they lie in the field. The city dump is an additional source in Suva, whilst the pest will also breed in stable manure. In this latter situation however ants destroy quantities of the eggs and maggots, so that the most important origin of the pest is undoubtedly cow manure. The fly is filthy in its habits, feeding upon human expectoration, vomit, the fæces of dogs, fowls, &c., and also feeds upon and breeds in human fæces.

The biting fly *Stomoxys calcitrans* seems to have become much commoner than formerly and a high proportion of the pupæ collected in stables proved to be this species. It was also the only species found in rotting grass cuttings. It is not a common house-fly, but bites in the open. It is elsewhere under grave suspicion as the vector in anthrax, infantile paralysis and certain trypanosome diseases.

CONTROL OF FLIES BREEDING IN COW DUNG.

The possible methods of controlling cow dung breeding flies divide themselves into two sections:—

1. Mechanical or artificial control.
2. The introduction of natural controlling agencies.

1.—Artificial Control.

In the closely-settled areas such as Suva, the prohibition of cattle would undoubtedly prove an effective method of dealing with the pest. The less drastic method of spreading the dung could alternatively be applied to certain areas. This would require to be done whilst the dung was sufficiently soft to spread thinly and also sufficiently frequently to expose the larvae whilst still small, as I have observed that when they reach a certain size they burrow into the ground if their food gets too hot, returning again to feed when it cools down in the evening, whilst a lump the size of a cricket ball will support a large number of maggots. I think it would be necessary to spread the dung twice a week, perhaps oftener.

The above mechanical methods could, of course, only be applied to restricted areas and would not be practicable in large districts such as the Rewa Valley, where flies are particularly prevalent, or to Taveuni, where they are equally troublesome, although I do not, as yet, know that in the latter place we have to deal with the same species. In those cases some method of natural control is desirable if a promising one can be found.

2.—*Natural Control.*

In other parts of the world two house flies, viz., *Musca autumnalis* in Europe and *M. enteniata* in India, are known to breed in cow dung, whilst *M. bezzi* and one or two others in India use the same medium, but I have no record whether they are house flies, as the two former ones are.

In Malaya the house fly has not been definitely identified, but *Musca* sp. (?) *Bakeri* (?) is recorded as breeding in horse and cow dung by Gater and although he does not actually state that this is the one found in houses the text infers it. Gater does, however, state that "the house-fly is not very abundant, but that plagues do sometimes occur," and traces the origin of one such (Bull. No. 83, Malaya Agri. Dept., p. 36). My own experience in that country was that, despite the great number of cattle present, also buffalo and wild oxen, flies were so scarce as to be a subject of comment when observed in the houses, and if their house fly does, as suggested, breed in cow dung, it must be under extremely efficient control. This also applies to Java.

There is another fly, however, which breeds in cow dung and which has become a major pest in certain parts of the world and that is the Horn fly, *Lyperosia irritans*. In parts of America it makes it impossible to fatten cattle at certain seasons, and in the Hawaiian Islands it has become a most serious matter to cattle raisers. Allied or identical forms are also pests in other parts of the world, notably Northern Australia. In the Hawaiian Islands serious attempts to control it have been made, working along two lines of research:—

1. By the introduction of parasites and direct predators such as *Staphelinidæ* and *Carabidæ*.

Of parasites we have in Fiji only the *Spalangia*, recorded above, and this I have as yet not recovered from cow dung bred pupæ. Of the predators, both groups are very poorly represented in Fiji and the introduction of certain of them should prove beneficial from many points of view. A large *Staphelinid*, *Creophilus erythrocephala* imported into Hawaii from Australia, bred freely in captivity and fed upon maggots in cow dung (Rep. of Commr. of Agri. and Forestry, Hawaii, 31/12/22, p. 57).

2. The second method which is the one upon which the Hawaiian authorities are placing the most importance is to destroy the dung by means of dung-burying beetles. It would therefore be well to compare the early stages of the two flies under consideration:—

<i>Fijian house fly.</i>	<i>Hawaiian Horn fly.</i>
Oviposits in cow dung some hours after deposited.	Oviposits in cow dung immediately it is dropped.
Bulk of larvae take 7 or 8 days in summer to mature, full-fed larvae being present in dung of 8 or 10 days of age.	Full-fed larvae found in dung of 4 to 6 days of age.

From the above it will be seen that any agency which destroys the dung will have about double the time in which to complete the work in Fiji against the house fly to that which it has in Hawaii against the Horn fly. So that any measure of success which may have attended their efforts there, can be hoped for to a far greater extent here, against our slower breeding insect, employing the same agencies.

Birds were also suggested for their problem, the American Cow bird being one, which, living specially upon larvae in cow dung, was particularly under consideration. It was however discarded on the grounds that it might eat rice. A bird to which I think no objection could be raised is the Australian Wagtail; it however generally catches its prey on the wing*.

On the whole I am of opinion that dung-burying beetles offer the most promising line of investigation for natural control with a view to dealing with the pest over Fiji as a whole. I have therefore made inquiries in Hawaii to see what, if any, measure of success has attended their efforts and will report on receipt of reply. I have also written to Malaya to ascertain definitely if their cow dung *Musca* is also their house fly and, if so, what agencies hold it normally so efficiently in check.

In Malaya I noticed flies, in very small numbers, on the faces of cattle. These would be, almost certainly, *Lyperosia exigua*, allied to the European Horn fly *L. irritans* and which breed in cow dung. Their small numbers suggest that the natural control of cow dung maggots is, in that country, extremely efficient.

APPENDIX A.

AGE OF DUNG USED BY FLIES FOR OVIPOSITING.

In my earlier reports I gave 24 hours as the approximate age of cow dung when used by the house fly as a medium in which to oviposit. I now find that in dry, hot weather this time may be considerably shortened. Marked dung of four hours had formed a crust almost suitable and flies have been observed settled upon, but not ovipositing, in dung of about that age, whilst eggs have actually been found in dung lying in hot sunshine and known to be as young as $4\frac{1}{2}$ hours. On the other hand flies were on another occasion observed ovipositing in dung known to be that of the day before.

As a result of a large number of observations I would now say that "house-flies oviposit upon cow dung when it has formed a thin leathery crust." This crust may become suitable any time between 4 and 24 hours, but if, from weather conditions or shade, its formation is delayed much beyond this time it becomes unattractive to the adult fly as a medium on which to oviposit.

In confirmation of this latter it was observed that dung dropped in the shade at 10.30 a.m. of the 23rd, had a suitable crust at 10.20 a.m. of the 25th, two days later. No eggs were however found in it and it did not seem to attract flies. It had also been observed that dung dropped in the open, on very hot, dry days, frequently forms its crust so quickly that it is not used, possibly because not found, by the house-flies, but only bred *Sarcophagidæ*. In wet weather the formation of the crust is generally so delayed that the droppings are not used by the house-fly to breed in.

Observations carried out to try to show how long the dung remained suitable for the flies to oviposit upon were not very successful. In no case were unhatched eggs found the day following the one on which the first eggs were observed being deposited. Flies were one day observed on dung over 24 hours of age. No fresh eggs could however be found and their presence may have been due to a moist condition following heavy rain. Probably weather conditions influence the period that the dung remains suitable for ovipositing very considerably, but that period is undoubtedly normally only

* Since this was written I see that an attempt has just been made to introduce this bird into Hawaii.

a matter of a few hours. The nearest I was able to get to this time was on March 7th, when dung dropped in the early morning was found to be attracting flies at 10 o'clock, but no eggs could then be found. (The droppings would then vary from about 3 up to about 5 hours of age). At 2.30 p.m. eggs were present, unhatched and a few flies appeared to be still ovipositing. This would mean that the conditions probably remain suitable for from 4 to 6 hours according to the weather, and very little longer, as the crust was hardening fast. The day was sunny with some clouds and a light breeze. In the night slight rain fell slightly softening the crust. Despite this, however, the droppings did not attract any flies the following day.

In connection with the above, it is of interest that I observed, in the laboratory, that larvae which, from food shortage, were delayed in their development, failed to mature. If this applies in nature also, it would mean that any flies which oviposited late would lose their offspring and this would naturally tend to keep their ovipositing instinct to narrow limits in relation to the breeding medium.

APPENDIX B.

DATA OF BREEDING EXPERIMENTS WITH HOUSE FLIES IN LABORATORY.

Eggs laid in cow dung between 10 a.m. and 11 a.m. of February 3rd, 1928, hatched between 7 p.m. and 9 p.m. of the same day, giving an incubation period of about 9 hours with a temperature of 86° F., maximum falling to 74° F. at time of hatching.

In the field the first pupa was found on the 9th, but it is not absolutely certain that it was from this brood. The majority of the larvae had however pupated by the 11th and emerged as adults on the 16th and 17th.

Check experiments in the laboratory showed slightly slower development, pupation taking place chiefly on the 12th and 13th. The emergences were as follow (the pupal period can be averaged at 6 days):—

Date.	Emergent males.		Female.		Unknown.		Total.
17/2/28 ..	39	....	61	....	1	....	101
18/2/28 ..	78	....	87	....	25	....	190
19/2/28 ..	47	....	21	....	..	....	68
20/2/28 ..	11	....	2	....	..	....	13
	175	....	172	....	26	....	372

It will be observed that females were much in excess on the first two days and males on the last two. This order of emergence was unexpected and is not usual on other orders. It was partially supported in breeding out another large batch, where however the results were obscured by a big excess of males.

A considerable number of timed pupæ have given a very constant pupal period, in warm summer weather, of $5\frac{3}{4}$ to $6\frac{1}{4}$ days. This means that the above larvae took eight, nine and ten days to feed up, the majority taking nine.

A second big batch bred through in the laboratory on human fæces also took eight, nine and ten days for the larval period.

A third lot, in which the eggs were laid in cow dung on February 29th and which were supplied with an abundant supply of food, commenced to

pupate early on March 7th, being about 6 days 11 hours in the larval stage for the minimum, the whole pupating within the next 24 hours. The temperature was very warm and muggy during this period with a mean maximum of 87.5° F. and a mean minimum of 76.16° F. from February 29th to March 12th, when the first adults emerged. The whole period of this brood from egg to adult was 12 and 13 days. The emergences taking place as follows:—

Date and time.				Males.	Females.	Escaped.	Total.
12/3/28—	9.30 a.m.	..	..	35	39	..	74
	11.30 a.m.	..	..	25	25	1	51
	2.30 p.m.	..	..	8	3	..	11
13/3/28—	9 a.m.	..	..	13	10	1	24
	10.30 a.m.	..	..	1	4	..	5
				82	81	2	165

All the above came from one batch of eggs, but not necessarily one parent. It therefore seems that the average larval period in normal summer weather is about 7 or 8 days, with a minimum of 6½ in very warm spells. The pupal period works out at about six days with a minimum of just over five in exceptionally warm periods. In the cool season both these times are likely to be considerably extended.

APPENDIX C.

EFFECT OF EXCESSIVE RAIN AND MOISTURE IN FLY PROBLEM.

A long spell of very wet weather lasting from the 16th March enabled some observations to be made upon the effect of such wet conditions upon the fly problem. Cow droppings were examined on the 29th, when it was found that the rain had so far prevented ovipositing that only in one instance were maggots found and then only very few in number and no sarcophagids. The presence of the maggots in this one instance showed that the wet weather had largely prevented ovipositing, but had not rendered the drippings unfit for the development of the maggot. Wet weather may however lead to heavy mortality at the time that the maggots leave the manure to pupate, as it has been observed in the laboratory that when the surrounding soil is sodden the maggots continue to wander in search of a dry pupating spot for four, and even five days, but eventually pupate. Maggots removed and placed in dry conditions pupated within a few hours. The emergences showed that whereas those transferred maggots reached the adult stage as follows:—2 on 19th, 15 on 20th and 1 later (night of 20th), those left under moist conditions emerged as follows:—1 on 18th, 4 on 10th, 35 on 20th and 33 later (21st and 22nd). It will thus be seen that placed into dry conditions caused rapid pupation, whilst of those left under moist conditions half were delayed at least 24 hours.

A STOCKYARD TO HANDLE SMALL HERDS.

By C. R. TURBET, B.V.Sc., Government Veterinary Officer.

CATTLE which have been handled periodically are more tractable and require less time and labour to muster for shipment, branding, inspection, &c. They become accustomed to humans and are less trouble on plantations. Government Veterinary Officers are required to inspect all cattle periodically

but, in many cases, proper inspections cannot be made and much time is wasted on account of the lack of yarding facilities.

The following particulars are published to assist stock owners in constructing suitable stockyards for the convenience of owners and inspecting officers.

Site.—The stockyard should be accessible to homestead, and to grazing lands, to avoid the necessity of driving stock long distances; and for convenience in working. It should be on level slightly elevated land to provide good drainage. The corner of a large paddock is usually the best. The side fences of the paddock act as wing fences to assist in the mustering. If possible a good water supply should be in the vicinity.

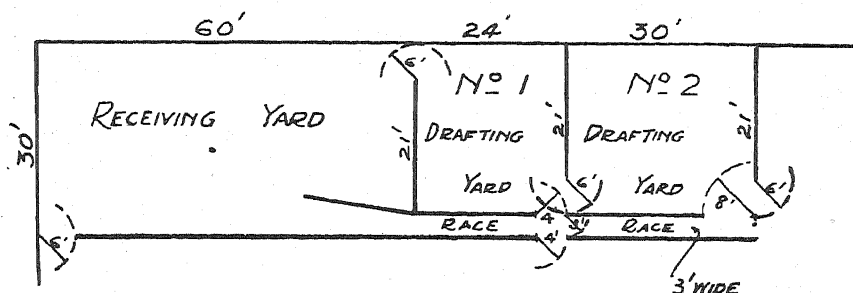
Fences.—These might be constructed of bush hardwood timbers of better quality. They should be stout, and bark and sap-wood should be cleaned off. The posts should be of good bush hardwood, with bark and sap-wood removed, and well dried; 9 in. by 8 ft. 6 in. when dry is a sufficient size. The butts should be tarred and sunk 2 ft. 6 in., panels 6 ft. to 8 ft. The fence rails should present a smooth surface to the inside of the stock-yard, and may be fastened by morticing, or by tying on with galvanized wire twisted tight on the outside. If the rails are tied on, the ends of the rails should well overlap each post. The rails should be so close together as to deter an animal from attempting to break through, and to hold calves. The height of the fence should be 6 ft.

Dimensions.—As provided in the plan, the receiving yard is 60 ft. by 30 ft. and should hold up to 100 mixed cattle. It is entered by a gate 6 ft. wide. From the right-hand corner of the end opposite the entrance gate, a race 3 ft. wide is continuous with the right-hand long side of the receiving yard. A wing fence 16 ft. long directs animals into the race. Twenty feet along the race, a gate should be constructed on each side of the race, opening on the left into the first drafting yard, and on the right into the open paddock. Immediately past these two gates (24 ft.) the race is blocked by a 3 ft. gate across the race, which when open provides a free passage along the race. At the end of the race on the left side an 8 ft. gate hung on the end post is provided, opening into the second drafting yard. The end of the race can be left open, or provided with bails for securing animals by the head for such operations as dehorning and ringing of bulls.

Gates.—These should be stoutly built of 6 in. by 1½ in. timber, well braced, and of the same height as the fences. They should in most cases be hinged so as to allow swinging in both directions. A good type of hinge which cannot be lifted off by charging cattle consists of two ring bolts. The ring of one, in the making, being included within the other like a link. One bolt is bolted right through the post, a large washer being included between the post and the nut. The ring of this bolt should be horizontal, the other bolt is bolted through the upright of the gate, which may need strengthening where the bolt goes through. A modification of this is to have instead of a bolt a flat piece of iron, which is pierced by smaller bolt holes. This is bolted to the gate after the manner of an ordinary hinge.

Explanation.—The stockyard, as designed, is sufficient to deal with about 100 head of cattle at one time. It can also be used for horses. The cattle are mustered into the receiving yard and passed into the race as required. The first series of three gates serve for drafting purposes, and can be operated by one man sitting on a cross beam above the race. Three classes can be drafted, the class going to the right being released. Those to the left are held in the first drafting yard, and those passing through the gate across

the race are drafted into the second drafting yard through the large 8 ft. gate which is left open for the purpose. The gates connecting the three yards are arranged as follows:—



PLAN OF STOCKYARD

From the receiving yard into No. 1 drafting yard, the gate is to the left, *i.e.*, on the side away from the race. Between No. 1 and No. 2 drafting yards, the gate is on the side nearest to the race, for the convenience of men in passing along the outside of the race when passing animals through. The gate leading out of No. 2 drafting yard is also on the side nearest to the race, in order to give free access to the end of the race when handling animals by the head for dehorning, &c. The large 8 ft. gate at the left side of the end of the race is provided for the purpose of throwing animals for castration, branding, &c. The near fore and hind fetlocks being secured to the lowermost rail of the right side of the race, a rope is passed from around the off upper fore-leg over the withers to the left side. The gate is then opened, and the animal is thrown to the left by pulling it off its balance by the rope over the withers. The end of the race may either be provided with a slip-rails stop, or be provided with some system of strong bails for securing animals by the head for such operations as dehorning, ringing of bulls, ear-marking, treatment of the eyes, &c.

IMPORTATION OF STOCK FOR WHICH A PERIOD OF QUARANTINE IS REQUIRED.

THE attention of the public is drawn to a regulation recently made under the Foreign Animals Importation Ordinance 1886 reading as follows:—

“The importer of any animal for which a period of quarantine is prescribed shall obtain, not less than one month prior to the advertised date of arrival of the vessel by which it is intended to import the animal, the written permission of the Superintendent of Agriculture to import the same. Provided that animals, imported for immediate slaughter, shall be exempt from the provisions of this Regulation.”

The regulations at present provide for the quarantine of imported animals as follows:—

Horses.—From the United Kingdom, Ireland, Canada and the United States of America.

Asses.—From France, Spain and Portugal.

Cattle.—From New South Wales, Victoria, South Australia, Tasmania and New Zealand.

Sheep.—From New South Wales, Victoria, South Australia.

Goats and Swine.*—Tasmania and New Zealand.

*(Note.—The importation of swine from all of the Australian States is at present prohibited.)

The purpose of this regulation is to prevent the quarantine station being taxed beyond its capacity at any one time. The present station, as the attached importation figures show, is sufficiently large to accommodate a much greater flow of cattle than now comes to the Colony. It is not large enough however to accommodate more than fifty head at once and when an enterprising planter recently imported seventy-three head in one shipment it was necessary to arrange for temporary quarantine grounds on very short notice. Temporary quarantine grounds are open to objections and this regulation will afford greater security to cattle importers as a whole.

1922	19 head.
1923	94 head (including one shipment of 55 head.)
1924	70 head (including one shipment of 61 head.)
1925	26 head.
1926	29 head.
1927	6 head.
1928 (February)	84 head (including one shipment of 75 head.)

These figures show that during the past six years there have been only three occasions on which cattle in excess of 50 head have been imported at one time and that there is no justification for the expenditure of public funds, at the present time, for the extension of the Animal Quarantine Station.

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12. JAN. 1929
A. R. I. P. 1929

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 1.]

THIRD QUARTER, 1928.

[No. 2.

EXTRACTS FROM THE ANNUAL REPORT OF THE BRITISH COTTON GROWING ASSOCIATION FOR 1927.

Page 25.—The future of Sea Island cotton cultivation in the West Indian Islands depends upon whether extended markets can be obtained for the produce, for which there has been very little demand in recent years. Sea Island cotton was formerly largely used in the manufacture of fine lace, which has been out of fashion for some time. Owing to the difficulty in disposing of the crop, it has been suggested that the acreage under cotton cultivation should be curtailed for the time being, and, although it is not easy to find an alternative crop in some cases, the reduction in area in most of the Islands appears to be well in hand.

Page 52.—In the Fijian Islands the crop of Sea Island cotton amounted to over 900 bales which was considerably better than had been anticipated. Unfortunately Sea Island cotton, which is the type cultivated, is not easily marketed at the present time, but when sales can be made the price repays the grower for the waiting. Meantime the Fiji Government make advances to the growers against the crop, and during the season the sum advanced was £15,000. The Fiji Government have been warned against over-production of Sea Island cotton on account of the poor demand.

ENTOMOLOGICAL NOTES.

By HUBERT W. SIMMONDS, F.E.S., Government Entomologist.

Elytroteinus substruncatus, Fairm.

THE larva of this beetle does much damage in Fiji to begonias, boring down the centres of the main stems, which die back or break off at the attached portion. As this is generally near the base, attacks frequently actually lead to the death of the plant.

The beetle is also recorded as a pest of ginger in Hawaii, whilst in the Cook Islands it is recorded as attacking the base of the stalk of lemons, thence boring into the pulp, where the larva pupates.

INVESTIGATIONS IN TRINIDAD ON A PARASITE FOR "*CLIDEMIA HIRTA*."

By T. H. C. TAYLOR, Entomologist, Coconut Committee.

CLIDEMIA HIRTA IN TRINIDAD.

A PRELIMINARY study of the control of the Melastomaceous shrub, *Clidemia hirta*, was undertaken in November, 1927, and continued until the end of January, 1928, with a view to finding some controlling factor which might be applied in Fiji. Owing to the pressure of other work, and the brevity of our stay in Trinidad, it is impossible to present a full report on all aspects of the problem; but the investigations made were sufficient to show that further work in Trinidad is desirable and might yield results which could be usefully applied in Fiji.

DISTRIBUTION IN TRINIDAD.

Clidemia hirta is widely distributed in Trinidad, but is rarely seen outside the forests. It was never found on sugar estates, except occasionally in damp ditches near streams. On coconut estates it is very rare and only appears on land which is badly drained. In the moisture of cocoa estates it is a little more common, but never sufficiently so to be regarded as a serious weed. It has never attracted any attention in Trinidad and is certainly of no economic importance there.

In the course of this and other work, nearly all parts of Trinidad, except the south-eastern corner, were visited. The districts in which *Clidemia* was examined included Cedros, and the forest between Cedros and Brighton, in the south-western peninsula; Couva, Pointe a Pierre, and Waterloo Estate, in the west; Maqueripe, in the north-western corner; Sangre Grande, Manzanilla, and the forest at the southern end of the Toco Road in the east; Brasso, San Rafael, and the Arena Forest Reserve, in central Trinidad; and many localities near the main eastern road between Port of Spain and Arima.

Clidemia hirta was found in all these localities, and there is no doubt that it occurs in suitable places all over the island. In the forest areas it is nearly always common, and wet, partially shaded land is certainly its natural habitat. A noticeable feature of its occurrence in the forest is that it occurs more at the sides of clearings, paths, and roads in the forest than in the more densely shaded parts.

The only district other than forest areas, in which it was found commonly is between San Rafael and Arima, on the Tumpuna Road, where there is a wide stretch of dense low scrub. The common occurrence of the shrub here was probably brought about by the lack of a dry season in 1927. Uncultivated country of this sort is unusual in Trinidad, and it is unlikely that *Clidemia hirta* would have flourished in it in a normal dry season. The observations of Urich indicate that the joint effects of its natural enemies and a dry season usually wipe it out in open situations, as pointed out hereafter.

Although *Clidemia hirta* is common in many parts of Trinidad it is never present in large quantities in one locality, but only in the form of isolated bushes. Even in the forest where it is most common, it never forms the

greater part of the undergrowth. The nature of the soil seems to have very little connection with its distribution.

CONTROLLING FACTORS.

Clidemia hirta is certainly efficiently controlled in Trinidad by natural means. The factors which are responsible for its control are—

1. Climatic conditions.
2. Pressure of other vegetation.
3. Insect enemies.

1. *Climatic Conditions* undoubtedly influence the distribution of *Clidemia hirta* to a great extent. An abundance of moisture is essential to it, and it is much more common and more flourishing in the wet season than in the dry. Although it is always found much more commonly in shady spots than in the open, the degree of shade is only of importance in so far as it concerns the conservation of moisture. *Clidemia hirta* is found in the full sun at the edges of marshes or in ditches, and the plants never suffer from the heat so long as the soil remains wet. Moisture is certainly the most important factor in Trinidad. The cooler climate which prevails at higher elevations seems to favour *Clidemia hirta* a little.

2. *The Pressure of Other Vegetation* must play an important part in the control of this shrub. The fact that it flourishes at the edges of shady paths in the forest and also in the sun round the edge of forest areas, and yet is rare in the undergrowth of the forest itself, supports this view. Further, it frequently appears during the wet season, in ditches which have recently been cleared and had previously been free from it.

3. *The Insect Enemies of Clidemia hirta* are few in number, and no fungal diseases of any importance were observed. There are only two insects which attack it commonly and these are a leaf-rolling lepidopterous larva (probably more than one species) and the thrips, *Liothrips urichi*. The leaf-rolling larvæ attack many other species of Melastomaceous plants, but although common, they are never sufficiently so to cause any material damage to the plants. The thrips, on the other hand, appears to be absolutely confined to *Clidemia hirta* and inhibits the growth of it. The precise extent of its importance in Trinidad as a control for *Clidemia hirta* is very difficult, if not impossible, to estimate, but, of all the factors concerned in the control of this plant, the thrips is the only one which could be applied to Fiji. For this reason a special study of its life history and habits was made in Trinidad, and the results, though incomplete on account of the pressure of other work, were satisfactory as far as they went.

OTHER MELASTOMACEOUS PLANTS IN TRINIDAD.

There are very many different species of melastomaceæ in Trinidad, most of them belonging to the genera *Miconia* and *Clidemia*. The identification of many of them is difficult on account of the great similarity which exists between different species, and in some cases identification is impossible unless the flower can be found. Several species are, at first sight, very similar to *Clidemia hirta*, particularly when they are growing together in the forest. All the common species were examined from time to time in many different parts of Trinidad in order to find out, as far as possible in the time available, whether the natural enemies of *Clidemia hirta* would also attack other closely allied plants and also whether any of the factors concerned in the control of the latter were applicable also to *Clidemia hirta*.

A collection of the common Melastomaceæ (21 species in all) was prepared in Trinidad and brought to Fiji in the belief that it might prove useful to other workers in this field. This collection contains the following species:—

1. *Clidemia hirta*, Don.
2. *Clidemia neglecta*, Don.
3. *Clidemia spicata*, D.C.
4. *Clidemia pustulata*, Schr. and Mort.
5. *Clidemia rubra*, Mort.
6. *Miconia racemosa*, (Aubl.), D.C.
7. *Miconia albicans*, (L.W.), Triana.
8. *Miconia prasina*, D.C.
9. *Miconia chrysophylla*, M'fulva., D.C.
10. *Miconia triplinervis*.
11. *Miconia lacera*, (Bouff.), Nand.
12. *Miconia virescens* (Vahl.), Triana.
13. *Miconia guianensis*, (Aubl.), Cogn.
14. *Miconia minutiflora*, D.C.
15. *Miconia ciliata*, D.C.
16. *Miconia acinodendron*, (L.), Triana.
17. *Miconia fulva*, D.C.
18. *Miconia tomentosa*, (Rich.), G. Don.
19. *Nepsera aquatica*.
20. *Aciotus purpureascens*, (Aubl.), D.C.
21. *Oxymeris rufescens*, Triana.

INSECTS ATTACKING OTHER MELASTOMACEÆ IN TRINIDAD.

The results obtained from this preliminary survey of allied Melastomaceæ were mostly of a negative nature but are nevertheless important in some respects. The most significant point as far as Fiji is concerned, is that the thrips, *Liothrips urichi*, never attacks anything except *Clidemia hirta*. (The evidence for this is given hereafter.) The leaf-rolling caterpillars attack nearly all species of *Miconia* and *Clidemia* (and probably many other plants in no way connected with these), and therefore cannot be considered suitable for importing into Fiji; moreover, although they are common they are never sufficiently so to play any part in the control of *Clidemia hirta* in Trinidad.

There are many other insects which are found on plants of this family, but, apart from the thrips, only two others appeared to be confined to them. These are, firstly, a Cecidomyid fly which was bred from the flowers of a species of *Miconia*, and secondly a curious moth, probably belonging to the family Gelechiidæ, whose larva causes remarkable galls in the stems of *Clidemia pustulata*.

The latter insect is abundant, and is absolutely confined in nature to *Clidemia pustulata*. An attempt was made to induce it to attack *Clidemia hirta* in the laboratory, but it would not do so, though further experiments of this nature are desirable. *Clidemia pustulata* is distributed throughout all the forest areas of Trinidad, growing in many places, in close proximity to *Clidemia hirta* and many other species of Melastomaceæ, and wherever it occurs the galls of the Gelechiid moth are present on it. It is, in fact, very unusual to find a plant of *Clidemia pustulata* which is free from these galls, and the stunted, gnarled appearance which the plants nearly always exhibit, is probably due to the larvæ of this moth. The larva lives in the centre of the stem of *Clidemia pustulata* where it hollows out a chamber for

itself, and causes the stem in its immediate neighbourhood to swell considerably. The walls of the chamber are thick and hard, and constitute a prominent oval swelling in the stem. There are usually many of these galls on each plant. There is no hole in the gall until the larva is full-grown, but having reached this stage the larva tunnels through the wall of its chamber to the exterior, closes the hole at the outer end with silk, and withdraws into its cell. It then spins a very tough silken cocoon in the centre of the gall, and pupates within it. The moth, which is not yet identified, eventually emerges through the hole.

The habits of this moth, and its effect on the plant, are very similar to those of another Gelechiid moth, *Phthorimæa* sp., which is a pest of tobacco.

Clidemia hirta and *Clidemia pustulata* appear to be the only Melastomaceæ in Trinidad which have absolutely specific insect enemies, the thrips in the former case and the moth in the latter. It is therefore significant that these two species of *Clidemia* are always less healthy in appearance and often less common than the many other Melastomaceæ which flourish round them in the forest.

LIOTHRIPS URICHI, KARNY, AS A NATURAL ENEMY OF *CLIDEMIA HIRTA*.

Liothrips urichi belongs to the family Phlæothripidæ and the sub-order Tubulifera, of the order Thysanoptera.

DISTRIBUTION.

Liothrips urichi occurs throughout Trinidad, wherever *Clidemia* grows. It is said to be more common in the dry season than in the wet, but we found it all over the island during the wet season. It seems to avoid plants in very deep shade, but otherwise shows no preference.

INDICATIONS OF PRESENCE OF THRIPS.

The thrips is very readily detected in its natural haunts because it causes the leaves and stems which it attacks to turn dark-brown or black and eventually to die. The first signs of its presence are small dark-brown spots on the leaves, and in the great majority of cases the youngest leaves at the tips of the shoots are preferred.

NATURE AND EXTENT OF INJURY.

Both the nymphal and adult stages of this insect are injurious to *Clidemia*. The dark spots result from the puncturing of the plant tissues by the thrips, which sucks out the sap. The attacked leaves droop and fall off, and the whole shoot is usually so greatly weakened that it dies. Frequently all the young shoots on a large bush are destroyed in this way, while the older leaves on the same bush remain healthy.

The thrips, by itself, rarely kills *Clidemia* except when it attacks young seedlings, but it greatly weakens the plants, and inhibits their growth. Plants which are badly attacked flower very little, if at all, and therefore the spread of the plant is hindered, probably to a great extent. According to Urich, a drought following thrips attacks is fatal to plants which could probably have withstood it in the absence of thrips. Infected bushes always have a stunted, unhealthy appearance and probably succumb readily to any additional adverse circumstances. We were impressed with the scarcity of fruit on *Clidemia* all over Trinidad and also with the complete absence of

large healthy bushes such as are to be seen in Fiji. Further, although isolated plants are common in many localities, large masses of them, covering considerable areas, are quite unknown. The thrips certainly plays an appreciable part in producing this state of things, but whether it is a sufficiently important factor to produce the same effect elsewhere we cannot say.

LIFE HISTORY.

The life history was studied in some detail in the laboratory. The adults are to be found on the young shoots, and rarely on any other part of the plant. The majority of them keep to the undersides of the two very young leaves at the tip of each shoot, but many are on the stems also.

The eggs are usually laid on the undersides of the youngest leaves, or on the stems, or in the angles between the petioles of the youngest leaves and the terminal buds. The undersides of the leaves and the young stems of *Clidemia hirta* are covered with a dense pubescence, and this makes the eggs, which are in contact with the surface of the leaf or stem, difficult to detect except when a leaf is held up to the light and examined with a lens. Eggs laid on the leaves are always placed near the bases of the leaves. Many eggs are laid on each shoot as a rule. The egg is pale-green and transparent when first laid, but becomes more opaque as development proceeds. In shape it is ovoid and elongate, and both ends are rounded. The duration of the egg stage is 8-9 days.

The young, first-stage nymph commences feeding immediately it emerges from the egg. On the following day a dark-brown spot appears on the leaf, marking the spot at which the nymph fed, and soon the leaf bears a number of these spots. The nymph grows rapidly and after four or five days the first moult occurs. Up till this time the nymph usually feeds on the undersides of the young leaf, regardless of where the egg was laid, but after the moult it often wanders down the stem and feeds there. Frequently the nymphs attack the petioles, causing the leaves to drop off, and this results in the formation of a soft scar on the main stem at the point of attachment of the petiole. The tissue at this spot is very soft and readily penetrated by the style of the insect, and therefore large numbers of larvæ are often seen crowding on to it. Seven days after the first moult the nymph is full-grown, and the second moult then takes place. The total duration of the nymph stage is therefore 10-12 days.

Throughout the nymphal period the head, prothorax, legs, and the two terminal abdominal segments, which are tubular, are black, while the rest of the body is bright red. This colouring makes the nymphs very conspicuous.

The second moult gives rise to the prepupal stage which is very short, and never occupies more than one day. It is terminated by the third moult after which the insect is in the pupal stage.

No further growth occurs after the second moult, and neither the pupa nor the prepupa is capable of taking nourishment. The insect is quiescent in both of these stages and usually remains more or less hidden on a shrivelled leaf or in the dense hairs at the base of a leaf throughout the non-feeding period, but the pupa and the prepupa are capable of slow movement if disturbed.

The pupa and prepupa are similar in appearance, but they differ considerably from the nymph. They too are red in colour, but of a lighter shade, and they are without the black markings which are so conspicuous on the nymph. The wing sheaths appear in the prepupa, but are short

and stumpy, and the antennæ are short and rigid, and project outwards. In the pupa the wing sheaths are long and unattached except at their bases, while the antennæ are folded back along the sides of the head.

The duration of the pupal stage is 5-6 days.

The adult remains quiescent for a day or two after it emerges from the pupal skin, and then begins feeding voraciously. It is black, opaque, and shiny. The wings are well developed in both sexes, but the insects rarely fly so long as fresh food is available. They wander actively over the plants, feeding on stems and leaves alike. Both sexes are common. Copulation was not observed, but on several occasions a female was seen with two or three males on her back. Parthenogenesis sometimes occurs. Three females, each of which had been reared by itself from the egg in a glass jar and had never come into contact with other individuals at any stage, produced fertile eggs. There is little doubt, however, that copulation is the rule. Oviposition seems to begin five or six days after emergence from the pupa. The total duration of the life-cycle, from oviposition to emergence, is about three and a half weeks (24-28 days).

The following table illustrates the life-cycles of sixteen different individuals. The records were obtained by the method described hereafter under "Laboratory Methods." The figures denote days:—

LIFE-CYCLE OF *LIOTHRIPS URICHI*.

Tube	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Egg Stage ..	8	9	..	8	8	9	9	..	8	8	8	8	8	..	9	8
Nymph I ..	}10	4	..	4	4	4	5	..	4	5	5	}11	5	}11 or 12	4	4
Nymph II ..		6	..	7	7	7	7	..	7	7	7		6		7	7
Prepupa ..	1 or less	1 or less	1	1 or less	1 or less	1	1	1	1 or less	1 or less	1 or less	1 or less	1	1	..	1 or less
Pupa	5	5	5½	5	6	5	5	5	5	5	6	6	5	6	..	6
Emergence to Oviposition	..	..	5	..	..	..	..	..	5	..	..	6	5	..	..	..
Egg to Adult .	24	25	..	25	26	26	27	..	25	26	27	26	25	..	..	..

LABORATORY METHODS OF BREEDING.

Liothrips urichi was found to be very easy to breed in captivity. A number of plants of *Clidemia hirta* were potted up with thrips on them. The thrips multiplied rapidly and did much additional damage to the plants, passing three generations in the laboratory without any attention. The experiment had to be abandoned at this point, but there was every indication that the plants would die in the near future.

For a more detailed study of the life history, small healthy shoots of *Clidemia hirta*, each bearing two young leaves, were collected in the field and placed in water in glass tubes. Each tube was then covered with a glass jar. *Clidemia hirta* lasts a long time in water, and provided the water is changed every day there is no need to renew the shoots more often than every ten days. A single female thrips was placed on each shoot, and a

record kept of its activities and those of its progeny, every day for seven weeks. As a result of its attacks on the shoot the leaves usually dropped off after four or five days, but the insects continued to flourish on the stem, and made no attempt to escape until the latter was dead. Thirty shoots in tubes were employed in this experiment.

ALTERNATIVE FOOD PLANTS.

The careful observations of F. W. Urich and C. B. Williams, which extended over a long period of years, would almost certainly have resulted in the discovery of an alternative food plant for this insect if it existed, but none was ever found. We felt fairly certain from this that the thrips was absolutely confined to *Clidemia hirta*, but in order to satisfy ourselves on this point we made a special search on all the other common Melastomaceæ, particularly other species of *Clidemia*, for the thrips, but we failed to find it; and this in spite of the fact that in many localities other species of *Clidemia* grow very close to *Clidemia hirta*, and between two or more plants of the latter species which bear thrips. It was not possible, on account of lack of time, to experiment with the thrips on crops of economic importance, and the possibility of its attacking them is very remote, but the next best thing seemed to be to prove that it will not attack other closely allied species of *Clidemia hirta*. If close allies of *Clidemia hirta* are immune from the thrips, it is extremely unlikely to attack other plants which have no connection with *Clidemia hirta*.

The field observations on other Melastomaceæ were fairly conclusive, but a few experiments were made, in the laboratory to verify them. Young shoots of *Clidemia postulata*, *Clidemia neglecta*, and *Clidemia spicata* were arranged in tubes in the same manner as those of *Clidemia hirta*, and thrips were placed on all of them. In every case the thrips refused to feed and died in two days, although those on *Clidemia hirta* flourished in the same conditions and at the same time. Further potted plants of *Clidemia neglecta* and *Clidemia spicata* were placed among similar plants of *Clidemia hirta* already infected with thrips, but were never attacked by it. Another plant of *Clidemia hirta*, apparently healthy when potted up, was added later, and was found to be infected after a few days.

We feel fairly confident, in view of these observations, in stating that the thrips is absolutely confined to *Clidemia hirta*.

NATURAL ENEMIES.

Urich has bred a Chalcid parasite, *Tetrastichus thripophonus*, Wtrst., from the prepupæ of *Liothrips urichi*. No other natural enemies are known. We did not find this parasite, and believe it to be uncommon as a rule.

CONCLUSION.

Clidemia hirta is efficiently controlled in Trinidad by natural means, but the only controlling agency which could possibly be utilised in Fiji is the thrips, *Liothrips urichi*, Karny. It is impossible to say what effect this insect would have on *Clidemia* in bulk in Fiji, and it is quite possible that under new conditions it would prove useless. Nevertheless, provided it can be proved to attack no plants of economic importance, as seems almost certain, it is, in our opinion, worthy of a trial in Fiji.

ACTION TAKEN IN REGARD TO CONTROL OF NOXIOUS WEEDS.

By J. KERMACK, Acting Superintendent of Agriculture.

THE following steps have been taken in regard to the control of noxious weeds:—

Clidemia hirta.—On the 23rd February, 1928, the following motion was agreed to by the Legislative Council:—

“ That this Council approves in principle the expenditure from General Revenue of funds to enable detailed investigations to be made of natural enemies of *Clidemia hirta* known to occur in Trinidad.”

With the approval of the Coconut Committee advantage was taken of the visit to Trinidad of Mr. Taylor, an Entomologist employed by the Committee, to have investigations made by this officer with the object of ascertaining whether any of the agencies which controlled the spread of *Clidemia hirta* in that island could be used in an endeavour to check the spread of the weed in Fiji. Mr. Taylor's report on his investigations has been received and published as Council Paper No. 14 of 1928.

Dr. Tothill considered that the Thrip referred to as likely to act as a control of *Clidemia hirta* could probably be introduced into Fiji without danger of its attacking plants of economic importance, but at the same time advised that every possible precaution be taken against hasty action as it could never be exterminated if found to be undesirable. With the approval of the Government, Dr. Tothill, therefore, wrote to the Principal of the Imperial College of Tropical Agriculture, Trinidad, asking if arrangements could be made for an entomological student at the College to conduct feeding experiments particularly on—

coconuts, cane, bananas, pineapples, cotton, Mauritius bean, rice bean, breadfruit, sweet potatoes, taro, tobacco, yams, para grass, paspalum, rice, dhal, peanuts, cocoa, rubber, tapioca, sensitive plant and maize.

A reply recently received from Colonel Evans, the Principal of the College, states that he has gone into the matter with the Acting Professor of Entomology and that, if this Government requires the experiments to be undertaken, he will ask Professor Ballou to make this investigation part of the work of a post graduate student in entomology who has already taken his degrees in entomology, as his main subject, and who is proceeding to the College for special tropical training for nine or ten months.

Sir Guy Marshall, Director of the Imperial Bureau of Entomology, has written to Dr. Tothill on this matter as follows:—

“ I have read with much interest Taylor's report on *Clidemia hirta* in Trinidad, and it would certainly seem, on the face of it, that there ought not to be much risk in introducing the *Liothrips*. At the same time, I cannot but feel that it is very improbable that it is this insect which is really keeping down the plant in Trinidad. A much more probable factor is severe competition with a number of closely allied plants. In any case, I see no objection to the very cautious plan which you have proposed, namely, that the whole matter should be fully investigated at the Imperial College of Tropical Agriculture. One of the things it seems desirable to

test is the actual effect, under control conditions, of the Thrips on the growth of the plant. Unless it can be shown experimentally that the insect can actually destroy the plant in Trinidad, there would hardly seem to be justification for introducing it into Fiji. Then, also, thorough starvation tests should be carried out with plants growing in close contact with infected *Clidemia hirta* to see whether the insect can be forced to adopt another food plant."

It is proposed to await the conclusion of the feeding experiments before taking any steps towards introducing the insect referred to into Fiji. His Excellency has, however, authorised the provision of £300 in the draft Estimates for 1929 to meet the cost of the experiments and of the introduction of the insect into Fiji if considered desirable.

Solanum torvum.—Consideration has been given to the question of the biological control of this plant. Briefly, the action taken may be set out as follows:—

- (a) Specimens of the plant have been sent to the Royal Botanical Gardens, Kew, for a verification of the determination.
- (b) The Kew authorities have been asked for a statement as to the original and present distribution of the plant.
- (c) Letters have been addressed to Directors of Agriculture, Entomologists, &c., in India, Ceylon, Burma, and the Federated Malay States asking for information on the fauna of this plant.
- (d) Sir Guy Marshall, Director of the Imperial Bureau of Entomology, has been advised of the action taken and has been asked for any advice he can give.

The Superintendent of Agriculture expects to pass through India on leave in about eighteen months' time and would be prepared, if the results of inquiries are sufficiently encouraging, to look into the matter and submit recommendations to the Government.

Lantana camara.—The spread of this plant is considerably checked by the following insects introduced by the Department:—

- (a) *Agromyza lantanæ*, a small fly which destroys seeds.
- (b) *Thecla echion* and *T. agria*, butterflies, the larvæ of which destroy flowers.

Agromyza lantanæ is well distributed throughout the group and the control exercised by this insect cannot be expected to increase. The two butterflies were introduced in 1922 and are now established on Vitilevu and Ovalau. They are not, however, available in sufficient numbers at the present time to permit of the collection of colonies for distribution in other areas.

Inquiries recently made by the Government Entomologist show that there is present, in Hawaii, an insect, *Teleonemia lantanæ*, which is reported to so damage the plant by the destruction of leaves as to cause a considerable reduction in seed production. As this insect is considered to be in every way suitable for introduction into Fiji, arrangements have been made to send the Government Entomologist to Honolulu to collect colonies and transport them to Fiji. The Governor has provided funds for this purpose and it is proposed that Mr. Simmonds leave for Hawaii on the 20th September.

PARASITES FROM TRINIDAD FOR THE COCONUT SCALE.

By T. H. C. TAYLOR, Entomologist Coconut Committee.

IN Trinidad, one of the islands of the West Indies, the Coconut Scale, *Aspidiotus destructor*, is well controlled by Coccinellid beetles. Five different species of these beetles, which are popularly known as lady-birds, were found to be instrumental in the control of the scale, and in January, 1928, many hundreds of each species were shipped from Trinidad for introduction into Fiji. They travelled *via* the Panama Canal and Tahiti, and eventually reached Suva on 5th March, after five weeks at sea. Despite the many hardships to which they were unavoidably subjected en route, particularly during transhipment in Panama, all the species survived the journey satisfactorily.

The beetles devour the scale very rapidly, and the maintenance of a constant supply of scale in the form suitable for feeding the beetles was the greatest difficulty encountered during the voyage. More than 200 young coconut palms, heavily infected with scale, were shipped in Trinidad, and nearly all this scale was devoured when the ship arrived at Tahiti. No further supply of suitable scale was available in Tahiti, and when the ship was still two days' journey from Suva the last of the young palms had to be put into the breeding cages. Fortunately, these proved to be just sufficient, and three days after reaching Suva, 600 beetles were liberated on Wakaya, the remainder being kept for breeding.

The scarcity of scale in the neighbourhood of Suva at that time made it necessary to take the beetles elsewhere for the purposes of breeding and distribution. Levuka was selected as the most suitable centre for this work, and another hurried trip to Wakaya yielded sufficient varas, already infested with scale, to feed the beetles in Levuka for a week or two, until more elaborate preparations could be made. Ever since, the work has been carried on in the neighbourhood of Levuka, and will be continued there for some months.

It was apparent at the outset that the methods employed in Trinidad for breeding the beetles in large quantities would have to be modified considerably in Fiji. The chief difficulty was that the beetles, in their early stages, proved to be heavily attacked by ants, and at one time the whole shipment, except for one species, was threatened with complete destruction by them. Also, the maintenance of a constant supply of scale-infested varas has caused much trouble, and occasionally the beetles have had to be kept on short rations until a further supply could be obtained. Apart from these difficulties, which have since been eliminated, the work has progressed very satisfactorily, and the beetles are now flourishing in Fiji, in spite of the new climatic conditions to which they are exposed. The new methods evolved for breeding them, which are described hereafter, are now perfected, and are working with almost mechanical efficiency.

IDENTIFICATION.

The names of the five species are:—

- (1) *Cryptognatha nodiceps*, Mshl.
- (2) *Azya trinitatis*, Mshl.
- (3) *Pentilia insidiosa*, Muls.
- (4) " Spotted " sp. (unidentified).
- (5) " Small " sp. (unidentified).

The colourings and markings of each species are sufficiently distinctive for identification purposes in the field. *C. nodiceps* is brownish yellow with two small black streaks in the middle of the back, side by side, and outside these a large irregular black blotch, on either side, extending almost to the hind end. This species is, however, liable to great variation, which takes the form of partial or complete union of the black markings, so that some specimens appear almost uniformly black. The surface is smooth, very shiny, and devoid of hairs.

A. trinitatis is uniformly dark-blue all over the upper surface, and is very densely covered with minute grey hairs, which make it look as if it has "bloom" on it, like a plum. It is shiny, but less so than *C. nodiceps*. The underside is brown.

P. insidiosa is extremely shiny, jet black, and hairless.

The so-called "Spotted" species is light-yellow with six prominent black spots on its back, three on either side, and a broad black streak down the middle of the back.

The "Small" species is shiny and very dark-blue, almost black, and sometimes exhibits a brownish iridescence. The head and thorax are brown.

In size, the first four species are comparable. Normal specimens are a little more than one-tenth of an inch in length. The last species, as its temporary name implies, is much smaller than the others, its average length being about one-sixteenth of an inch. All of them are hemispherical in shape.

There are two other scale-feeding Coccinellid beetles in Fiji which might be confused with the Trinidad species by those who are not well acquainted with them. The first is a species which has been known in Fiji for a long time and is often seen on scale-infested trees. It is jet black, except for the head and thorax, which are light-brown, and the surface is very shiny. It is larger and more elongated, relatively, than the Trinidad species. The second species is one which was imported from Java recently. It is smaller than any of the others, and light-brown in colour with a black patch at the anterior end of each wing-case and another at the posterior end. It is slightly hairy.

RELATIVE IMPORTANCE OF THE FIVE SPECIES.

As far as one can judge at present the order of importance in Fiji of the five species is as follows:—

1. *C. nodiceps*.
2. "Spotted" sp.
3. *P. insidiosa*.
4. "Small" sp.
5. *A. trinitatis*.

C. nodiceps is certainly much more efficient as an enemy of the scale than any of the others. It is by far the most prolific, and its life cycle is the shortest, of them all. Therefore it multiplies more rapidly. Probably *C. nodiceps*, by itself, is capable of doing all that can be done to control the scale by natural means in Fiji, and it is doubtful whether the presence of the others will increase the control materially.

LIFE-HISTORIES.

The life-histories of all the Trinidad species are very similar. It will be sufficient for the present purpose to outline the habits and life-cycle of *C. nodiceps* only.

The eggs are laid singly inside the scales. When ovipositing, the female beetle usually selects a full-grown scale, devours the contents, and then lays an egg in the space so formed. The egg is yellow, translucent, and shiny. In shape, it is ovoid and elongate, and one end is much more pointed than the other. Its length is equal to about half the diameter of a full-grown scale. The duration of the egg stage is five and a half days as a rule.

The young larva which emerges from the egg is very small and almost invisible to the naked eye. It is pale green at first, but after it has fed for a while it becomes yellow and is covered with a thin irregular deposit of white wax, with a row of delicate waxy tufts down either side. It begins to wander over the leaf as soon as it leaves the egg, feeding at intervals on the scale. After a couple of days it has increased considerably in size, and it then prepares to cast its skin. The wax is shed with the old skin, and after the moult new lateral waxy tufts are formed, and more wax, of a powdery nature, is deposited on the back. From this time onwards the waxy tufts are much thicker and more prominent, giving the larva the appearance of a mealy-bug.

The larva grows very rapidly, and it is full-grown twelve days (on the average) after it emerges from the egg. During this period it moults two more times, there being three moults altogether. It devours the scale at a great rate. The full-grown larva is of a deep yellow colour, but this colour is always obscured by the deposit of wax, so that, at a glance, the larva looks almost pure white. There is a thick dusting of wax all over the back, without any definite tufts, but down each side there is a row of eleven very long, thick, white tufts which project sideways over the leaf. Most of these tufts are as long as, or longer than, the width of the body. The second and third on either side are the longest, and the others become shorter and thinner towards the hind end. In addition to these there are two short tufts at the anterior and projecting forwards over the head, and a single, very thick, tuft at the posterior extremity which is directed backwards.

When the larva is fully fed it attaches itself firmly to the leaf or stem by its posterior segment and becomes hunched up on the back. It then casts its skin and becomes a pupa. The old larval skin is pushed back to the point of attachment but does not fall off, and the waxy tufts of the larva remain attached to it, forming an irregular bunch at the hind end of the pupa. The pupa produces no wax.

The pupa is short and thick-set. It is incapable of movement, except that it can jerk itself up and down when disturbed, as if hinged at the hind end. The colour is bright-yellow, and there is a double row of dark-brown markings down the middle of the back. It bears numerous short, very fine, hairs.

The pupal stage lasts four days, and the adult beetle then emerges, leaving the shrivelled pupal skin on the leaf.

The beetles feed very voraciously on the scale. They are capable of flying considerable distances when disturbed, or when they are in search of food, but so long as there is plenty of scale on the leaf they rarely leave it. They begin laying eggs about five days after emerging from the pupal skins. A small batch of twenty or thirty beetles will lay several hundreds of eggs on a single leaf provided the leaf bears plenty of scale, and the resulting larvæ are very readily seen at a glance. In cases like this, when the larvæ are crowded together on a single leaf, many of them invariably crawl down to the base of the leaf when full-grown and pupate in large clusters on the stem or on the fibre. These masses are very conspicuous.

Since the average figures for the duration of the egg, larval and pupal stages are $5\frac{1}{2}$, 12, and 4 days respectively, the total life-cycle, from oviposition to emergence, is a little more than three weeks; and as the beetles do not begin to lay until about five days after emergence, the period that elapses between the laying of the first eggs of two successive generations is about four weeks. A new generation is therefore produced every month. This has been tested by detailed observations in the laboratory and confirmed on a large scale by observations in the field.

The egg-laying period of each individual lasts for several weeks, and the total adult life lasts for at least two months in most cases. Actually, therefore, successive generations overlap considerably.

LIBERATIONS OF COLONIES.

About four thousand of the Trinidad beetles have been bred and liberated in Fiji between March and July, inclusive. At first it was thought necessary to turn out as many as four or five hundred beetles in each colony, in order that they might become well established, but recent observations at Lovoni, Ovalau, indicate that 150 are ample for each colony.

At least one colony has been, or will be, liberated in each badly-infested scale area throughout Fiji. On islands like Gau and Koro, one batch has been turned out on the west coast and another on the east. The beetles will distribute themselves from these centres, but when one colony has been liberated in each of the main areas the rate of distribution will be increased artificially by collecting some of the beetles from the original locality and removing them to other parts of that area by hand.

Following is a list of the main localities in which colonies have been, or will be, liberated:—

Vanualevu.—Wairiki, Solevu, Nadi Bay, Davutu, Muanicula, Wai-levu, Nagigi, Devadara, Dreketi.

Vitilevu.—Lower Rewa, Tailevu, Korolevu, Sigatoka.

Lomaiviti.—Ovalau, Wakaya, Naigani, Moturiki, Yanualevu, Nairai, Koro, Gau.

Lau.—Moala.

Yasawa.—Naviti.

Bega.

Kadavu.

Colonies have already been liberated on Vanualevu (at Wainunu, Davutu, and near Davadara), on Ovalau (at Lovoni and Bureta), on Gau (at Garani and Vanuasou), on Koro (at Nasau and Navanga), on Wakaya (at Korolevu), and on Nairai, Moturiki, Naigani, and Yanucalailai. By the end of September (possibly sooner) at least one colony will have been liberated in all the scale areas throughout the group.

METHODS OF BREEDING AND DISTRIBUTION.

At first the beetles were bred in Levuka in large cages stocked with varas which were heavily infested with scale. This method produced about five hundred beetles per generation in each cage, when it was working well, but frequently the numbers were greatly reduced through an insufficient scale supply. Unless ample scale is provided and maintained in the cages the larvæ become highly cannibalistic and reduce their numbers enormously.

The method which is now in use is giving far more satisfactory results. A patch of bananas at Cawaci, all bearing an abundance of scale, was selected, and a large number of cheese-cloth bags, each $1\frac{1}{2}$ yards long, were prepared. Each bag just fits over a banana leaf, and by tying the bag round the leaf stem at one end and closing up the other end, the leaf can be enclosed completely. Ants and other undesirables are excluded by putting a band of tanglefoot (a sticky substance which is weather-proof) round the base of the leaf stem. Beetles are put into the bag and are left there long enough to produce as many larvæ as can feed up on the scale available on the leaf.

Experiments have shown that the most convenient number of beetles to have in each bag is thirty and that a week is the most suitable period to leave them in the bag. If on 1st July, for instance, thirty beetles were put into a certain bag, they would be allowed to lay eggs in the scale, and feed on it, for a week. Then on 8th July, they would be removed, the bag closed up again, and the beetles put into another bag on a new leaf. On 15th July, they are transferred again, and so on, week after week, until they have laid all their eggs. The bag which was put on the leaf on 1st July will be full of larvæ of all ages on 15th July, and on or about 22nd July the first beetle will emerge.

The total number of beetles produced in each bag is at least 200, and often more than 300. In this way large numbers are produced very easily, and the method has the additional advantage of providing valuable data concerning the rate of multiplication, the rate of mortality, the egg capacity, and so on, under natural conditions.

PROSPECTS OF SUCCESS.

It is impossible yet definitely to predict what effect these insects will have on the scale in Fiji, but it can certainly be said that the prospects are hopeful. In all these localities which have been revisited some time after the original colonies were liberated, the beetles have been found to be very well established, to have multiplied greatly, and to have spread to some extent. Rapid results over wide areas, however, cannot be expected, and it will probably be a matter of several years before the full effect of the beetles can be estimated.

This account has been written primarily to give planters a general idea of what is being done and to enable those who wish to do so, to recognise the various species and to follow the activities of the beetles on their own estates. After the beetles have been liberated on estates, those in charge of the work will be glad to receive occasional reports on the rate of spread and on other matters connected with the scale which may arise.

INTRODUCTION.

By J. D. TOTHILL, Superintendent of Agriculture.

THE time is not far distant when Coconut Planters in this Colony will have to consider the question of replanting their estates and when that time comes it will be desirable to have ready a supply of seed of improved type.

There are individual coconut trees here and there that produce more copra than their neighbours because it is inherent in them so to do. If all the trees in a plantation were of the same stock as the few good ones the yield of copra would be greater than at present.

It has not been possible anywhere so far to collect the good trees into a plantation because most types of coconuts are dependent on cross pollination. Seed nuts collected from these isolated good trees have consequently produced disappointing trees because they are the result of female flowers on the good trees being crossed with the pollen of the ordinary trees near by.

If some artificial way could be found of carrying pollen from a good tree to the female flower of another good tree then the resulting nuts would have an extra good parent on both sides of the house and could reasonably be expected to produce trees as good as the parents. As the difficulties did not appear to be insuperable Mr. Maréchal, who in addition to technical training has had practical experience in plant breeding at the well known Javanese Experimental Station at Buitenzorg, was attached to the Coconut Committee Staff to explore the possibilities.

In the following article he shows how he has been able to keep pollen in an active condition for 16 days and explains how as a result of this he has been able to cross selected parent trees successfully. Three small nurseries of what are likely to be commercially pure strains of improved coconuts are now being established, and if the work is pursued diligently for a few years there appears to be no reason why a better seed supply cannot be made available to the community. Such seed will not be available in a few years because it takes up to ten years for trees to come into proper bearing. It can probably be made available by the time replanting has to be done on an extensive scale.

On the financial side there appears to be a reasonable expectation of increasing the output of copra from the Colony. By seed selection of the type indicated it might be increased by one-fifth and perhaps by considerably more. On the basis of one-fifth this would represent an increased value of exports of £100,000 per annum on the present output of approximately 27,000 tons.

We believe that Mr. Maréchal's preliminary observations and experiments will prove interesting and instructive not only to technical workers and plant-breeders but to planters generally, and he has therefore prepared a somewhat detailed account of his investigations for this issue.

OBSERVATIONS AND PRELIMINARY EXPERIMENTS ON THE COCONUT PALM WITH A VIEW TO DEVELOPING IMPROVED SEED-NUTS FOR FIJI.

By H. MARECHAL, Agronomist, Coconut Committee.

WHEN the coconut palm begins to bloom, which depending on the varieties and on climate, treatment, soil and other external influences, may be at different ages, it is the rule that one spathe appears in the axis of each leaf.

This spathe bends over either to the right or the left of the subtending leaf in a direction which is opposite to that of the spiral formed by the unfolding leaves.

Every year from 12 to 13 leaves are formed, depending on the variety and probably also on climate, so that one leaf and consequently one spathe corresponds roughly with one month in development. Ordinarily the spathe splits open over the full length commencing about 6 inches under the apex and on the side which is turned towards the subtending leaf. Sometimes it opens on the other side in a less complete way which results in part of the flowering branch or spadix remaining enclosed in the sheath or spathe, so that the spadix cannot develop properly. If, in such a case, spathe-borers are busy in the spathe many flowers will be damaged and become a total loss.

When the spathe is fully open, the spadix appears. It consists of a main stalk with numerous side branches each of which carries a large number of small buds. The branchlets which vary greatly in length for the different varieties, are placed in spirals on the main stalk. A careful study will show that there are four of these spirals.

If one start at the lower end and follows the first, second, third, and so on, of the branchlets it will be seen that there is a certain regularity in angle between 1 and 5, 5 and 9, 9 and 13, 13 and 17, &c. The same appears again when following 2, 6, 10, 14, &c., 3, 7, 11, 15, and 4, 8, 12, 16, 20, &c. Each of these series forms one spiral. The rounder the main stalk and the less flattened the whole spathe, the nearer these angles come to equal each other.

Some of the buds on the branchlets are larger than others, and appear as small spherical bodies more resembling small nuts than flowers. These however, are the buds of the female flowers, while the small ones are the male flower buds. The female flowers are usually placed on the lower ends of the branchlets alone, sometimes in couples or threes up to fives. Now if two female flowers occur on a branchlet, say, No. 3, it will often be seen that also 7, 11, and 15, &c., or some of these have two female flowers.

The diagram of a spathe which was called 8 of a Malayan dwarf coconut tree BS has the following aspect and may serve as a good example. The o's represent the number of female flowers on each branchlet of the spadix:—

Diagram of Spathe 8, Tree BS:—				oooooooooooooooooooooooooooooooo															
				oo o o oo oo o o oo															
				o o o o o o oo															
				o o o oo															
				o															
First Spiral	..	..	..	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Second Spiral	..	..	..	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Third Spiral	..	..	..	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Fourth Spiral	..	..	..	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
				o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

The first spiral has single female flowers except on branch 21, the second spiral has only single female flowers. The third and fourth however show

a strong tendency to two or more female flowers on each branchlet. The 13 at the end of the diagram were all situated on the end of the stalk.

It was noticed among the Malayan dwarfs that the spathes which open in the months from November till March tend to carry a larger number of female flowers than those opening during the other part of the year. It was also noticed that when a tree is coming into bearing, the first spadices to appear have, as a rule, only one or two spirals developed, while gradually after 8 to 10 months all four are carrying female flowers. Soon after that there may be a spiral developing doubles and so on. At the same time the number of branchlets increases till the maximum for that tree has been reached. This number is for the Malayan dwarf 30 or 31 including the end of the main stalk. For different types of Niu lekas these numbers vary from 50 to 70 and for Rotuma coconuts imported into Taveuni it was found to be 42.

The number of female flowers per branchlet varies for Malayan dwarf from 1 to 5, while observations on Niu lekas proved that more than 5 female flowers may be found on one branchlet. This is probably also the case with the common coconut in Fiji. The Malayan dwarfs on which these observations were made only started to bear a year and half ago and it is possible that the whole aspect of the spadices will change with the age of the trees.

It was found that trees producing female flowers regularly on most of the branches and with a tendency to form doubles and trebles, could be considered the healthiest and actually produced pollen more abundantly and of a higher vitality.

The branchlets which carry no female flowers are, as a rule, shorter than the others.

THE MALE FLOWER.

The male flower which is sessile consists of a perianth, six stamens, and a rudimentary pistil. The perianth consists of 6 floral leaves placed in two whorls of three each of which the inner whorl has leaves at least three times as long as the alternating other three. These leaves are more or less pointed and vary in colour from pale-yellow and green to orange. The six stamens are placed inside the inner whorl of perianth leaves and produce a yellow dry powder which is called pollen. In the centre of the male flowers a rudimentary pistil can be seen bearing three triangular points bent slightly outwards. Alternating with the points are three nectar glands, exuding an agreeably scented honey, which attracts all sorts of insects. The pollen is shed as soon as the flowers open. It is then dry and easily spread by the least bit of wind.

The male flowers are crowded, with more or less space between them, from the tops of the branchlets down as far as the female flowers. Closed, they are about half an inch long, pointed and triangular on transverse section. Their shape is sometimes very irregular especially when the number is very large, so that the flowers have been closely and tightly packed.

One or two male flowers may sometimes be found alongside the females, sometimes none at all. This has to be watched closely when a spathe is to be emasculated for pollination experiments, lest these few flowers, so easily overlooked, cause selfpollination.

The male flowers begin opening at the ends of the utmost top branchlets, subsequently those of some of the lower top and middle branches burst open. When the middle branchlets are fully open 40 to 60 per cent. of

the flowers on the top branches have ceased shedding pollen and have dropped, while at the same time flowers of the lower branches commence to open.

THE FEMALE FLOWER.

The female flowers are sessile and situated on the lower part of the branchlet. When the spathe opens they are from $\frac{1}{2}$ to $\frac{3}{4}$ inches in diameter and equally long, of a creamy colour and totally enclosed in the perianth leaves. Once light enters the spathe they grow rapidly but it still takes from 8 to 30 days to grow to full size, from $\frac{3}{4}$ to $1\frac{1}{4}$ inch in diameter. Then the perianth is of a green to reddish hue according to variety. The perianth leaves, of which there are six as with the male flowers, are also here placed in two whorls of three. The larger three are kidney shaped and at first enclose the gynæcium or pistil entirely while the smaller ones which are very thick and strong form a strong base for the female flower and later for the small coconut. Gradually the larger perianth leaves part and expose a pointed triangular surface of the gynæcium of which the top splits into three points. These points slowly bend backward and turn a rib with a rough surface upwards. The roughness of these ribs is caused by protruding long shaped cells of unequal length, which form the stigma of the pistil. Each of these three ribs corresponds with one ovular cavity in the base. Each cavity contains one ovum, of which as a rule only one develops into a seed, the later coconut. However, sometimes two or even all three grow into seeds and this is the cause of coconut trees with two or three stems growing out of one planted nut.

Alternating with the three points of the stigma, in the space surrounding these, three dark coloured slits or pores can be seen, the nectar pores, which exude large drops of honey. The production of nectar begins when the top of the pistil splits and the ribs of the stigma become exposed and lasts until the stigma starts withering.

Another fluid is secreted through numerous pores both in region where the nectar pores are and also below this. This fluid is sipped away by insects like the nectar but leaves small white crystals, probably of calcium oxalate, which gives the top part of the pistil a powdered appearance.

THE MALE PHASE.

Very few data are available concerning the male phase of the Malayan dwarfs. With this variety the male phase begins as soon as the spathe opens and finishes near the end of the female phase. But nearly all the trees on which observations were made were used for pollination purposes and consequently had to be emasculated. The male phase of Malayan dwarfs was never observed to end before the female phase began, as it does in Niu lekas and Rotumas. In those varieties the male phase is always finished from 1 to 5 days before the female phase commences.

THE FEMALE PHASE.

Before duration of the female phase can be determined it must be known exactly when the female flower is receptive. Receptivity begins when the three points of the stigma are well bent back and a fluid exuding from between the protruding surface cells moistens the narrow ribs. The stigmas are then white. Nectar flowing from the slit-shaped pores is produced several hours before receptivity begins and continues to flow during the whole receptivity period and some time after. The nectar spreads a

rather agreeable scent which attracts all sorts of insects. Several drops of this nectar collected in a small phial kept the scent for several days even after the fluid started fermenting. This nectar contains sugars and also some other constituent which is deadly for pollen submerged in it. Sugar solutions do not kill pollen but cause it to germinate.

The stigmas remain receptive from twenty-four hours to two days depending on the variety of coconut and it appears to me that they remain longer receptive when not pollinated, that is, if bagged so that no insects can reach them.

The following data on the female phase were collected on Niu lekas:—

Tree.	No. of Spathe.	No. of days between opening of Spathe and first female receptive.	Duration of female phase in days.	Total.
A3	9	27	7	34
A4	10	..	2	..
	9	..	..	27
	8	28	2	30
Bo	11	16	5	21
	10	16	16	32
	9	9	20	29
B2	8	24	4	28
Co	10	24	2	26
	11	21	7	28
C5	9	..	12	..
	8	30	2	32
D1	11	30	3	33
	10	31	8	39
	9	27	..	..
D3	9	30	7	37
	8	31	2	33
D4	10	..	4	..
	9	29	3	32
D8	9	26	3	29
	..	21	3	24
D10	10	..	8	..
	9	32	4	36
E2	8	28	5	33
E3	9	..	5	..
F6	10	..	3	..
	9	32	2	34
	8	28	4	32

It will be seen that the female phase lasts from 2-20 days, mostly, however, from 2-8 days, and the period between opening of the spathe and the end

of female phase is from 21 to 39 days, which means that in many cases, here in 13 out of 21, the spathes come open before the female phase of the preceding one is ended. But as the male flowers never open until 7 to 10 days after opening of the spathes there is no chance for self-pollination.

From 58 spathes of Malayan dwarfs on which experiments were made and which have been closely watched, the opening dates are known and also the dates on which the first female flower became receptive:—

Tree.	No. of Spathes.	No. of days between opening of Spathes and first female receptive.	Duration of female phase in days.
A6	10	12	7
	9	9	13
	8	11	15
	7	12	10
B3	10	15	9
	9	15	12
	8	17	..
B6	11	10	9
	9	13	10
	8	16	7
B7	10	5	8
	9	12	10
	7	12	8
B8	11	14	12
	10	14	10
	9	15	10
D2	11	15	6
	10	20	8
	8	18	5
D5	10	17	9
	8	10	12
D7	10	5	17
	9	13	14
	8	12	9
E3	10	7	15
	9	16	6
	8	15	9
E5	10	15	8
E6	10	15	11
E7	10	10	11
	9	12	13
	8	8	9
F2	10	8	16
	9	20	4
	8	11	13

Tree.	No. of Spathe.	No. of days between opening of Spathe and first female receptive.	Duration of female phase in days.
F3	10	18	6
	9	19	..
	8	14	10
F6	8	9	15
F7	11	7	..
	10	16	8
G4	11	12	4
	10	11	10
G5	10	16	11
	9	11	6
	8	17	7
	7	16	..
G6	9	6	11
	8	23	3
	7	10	..
G7	11	9	..
	10	19	6
	9	16	..
	8	16	5
H6	10	9	14
	9	19	4
	8	11	13

The trees B3, B8 and G5 show some regularity in the duration of the period between the opening of the spathe and the first female flower becoming receptive. Only B8 has regularity in the duration of the female phase. It can be seen that the first female flower becomes receptive within 5 to 23 days (mostly within 10 to 16 days) from the opening of spathe while the female phase lasts from 3 to 17 days (mostly from 5 to 13 days).

As a rule only one or two female flowers on the lower branchlets of the stalk come open first, then after a few days some more become receptive and these may be found on any part of the spadix while the female phase ends with a few late-comers usually much smaller flowers at the top and also at the lower end of the stalk.

THE POLLEN.

Pollen when fresh is a dry pale-yellow powder which is produced in the anthers of the stamens. A pollen grain of the coconut is globular without any points, irregularities or markings and with a smooth surface. It consists of an outer cuticularised membrane called extine, and a very thin inner cellulose membrane, the intine. This intine contains a fluid, plasma, in which are submerged granules and two larger bodies, nuclei, one of which is the male reproductive cell, or generative cell, the other being termed vegetative cell of the pollen grain.

When submerged in a weak cane sugar solution a pollen grain absorbs water and begins to germinate through a small opening. In the extine, the germinating pore, a small tube is emitted, which is a protrusion of the intine. In this the granules may be seen moving as small currents.

In a suitable solution the pollen tube may grow out to 30 or 40 times the diameter of the pollen grain. This can be easily observed by letting pollen germinate in a so called hanging drop. If no glass rings are available for these hanging drops, cardboard rings may be suitably used and if the tests have to last from 6 to 24 hours or longer it will be well to moisten the paper rings with water by means of glass capillaries and by placing the preparations in a so-called moist chamber.

COLLECTING POLLEN.

Pollen can be collected at once from the tree by tapping the spadix or the branchlets separately, holding a black paper underneath, but there must be no wind. This system, however, is very unsatisfactory, because one has to carry—besides black paper, brushes and glass tubes—also a dessicator into the field. I found it more satisfactory to cut several of the middle branchlets of a spadix of which the top branches have ceased blossoming, close to the main stalk, bundle them together, and bring them home in a strong brown-paper bag.

It will be well to collect the flowers just before leaving the field to prevent them from drying out too much. The best time for cutting is apparently in the early morning after the dew has dried up about 8 a.m. The flowers must be placed in fresh water as soon as possible, after cutting the stem afresh with a sharp knife or secateurs. After removing all the dead and empty flowers, the insect eaten ones, the borer dirt, and eventually earwigs, one or two branches are placed in each of six or seven glass tubes about one inch in diameter and four inches long. The glass tubes are in their turn placed in a tube stand in a slanting position, so that the branches do not stand upright, but nearly horizontal. The tube stand is then placed on a black paper in a flat box, for which a kerosene box is rather useful, and covered with a pane of glass or a piece of perforated zinc, in order to keep flying insects away.

If the branches are collected in the early morning many of the flowers will come open within a few hours and during the warm part of the day, so that the pollen may be collected, the same day in the afternoon. If, however, the branches were cut during the afternoon the flowers will not come open that same day, but can stand over till the next day and the pollen may be collected about noon. There is very little or no difference in vitality of pollen collected one way or the other. If no black paper is available, smooth drawing paper can be twice coated with good India ink and dried well. If kept dry and free from moulds such paper can be used a long time.

When the pollen is to be collected the branchlets in the box are gently tapped causing the pollen still in the anthers to fall on the black paper. The tube stand with the flowers is removed and the pollen gathered on the paper with a very soft camel hair brush, if possible a flat one. With a fine soft brush, No. 1 and 2, the pollen is subsequently picked up and placed in small glass tubes, which in their turn are placed in a suitable dessicator. It is convenient to divide the quantity of pollen among many tubes, especially if it is to be used on different days. These tubes are loosely closed with a plug of cotton wool.

PRESERVATION OF POLLEN.

The problem next to be considered is how to keep pollen in a highly viable condition and for what length of time. Literature on this subject is scarce. H. C. Sampson in his book "The Coconut Palm," writes that pollen can be kept for several days in hermetically sealed tubes without losing its vitality. C. X. Furtado [in the "Gardens Bulletin," Straits Settlement of 7th November, 1924, page 267] says, that after 7 days only 3 per cent. of the coconut pollen germinated in a 20 per cent. cane sugar solution. Aldaba [in the "Phillipine Agriculturist" of December, 1921, page 207] claims that pollen grains of coconut germinate in a 5 to 30 per cent. cane sugar solution and remain viable from 2 to 9 days. These last two authors do not mention how they preserved their pollen.

These experiments were repeated by me as far as possible and the results were very unsatisfactory. Comparative tests were made in hanging drops with fresh pollen from a tree growing at the Experimental Farm at Nasinu in the following solutions: saccharose 20, 25, and 30 per cent.; glucose 10 and 15 per cent.; bees honey and nectar gathered from female flowers.

See following Table I.

I.—POLLEN FROM TREE I, NASINU EXPERIMENTAL FARM.

Cut, 12th May, 1926. Pollen shed and collected, 10.30 a.m., 13th May, 1926.

Date of Test.	Tree.	Germination Fluid.	Germination—Test started at 10.30 a.m.
13 May, 1926	I	Sacchrose, 20 per cent. . .	4 p.m. a few have germinated, tubes formed $\frac{1}{4}$ –2 \times diameter, they did mostly burst.
	II	Sacchrose, 25 per cent. . .	4 p.m. 60 per cent. germinated, tubes 3 \times diameter, many burst.
	III	Sacchrose, 30 per cent. . .	4 p.m. few tubes are formed, 70 per cent. burst.
	IV	Glucose, 10 per cent.	4 p.m. 7 per cent. formed, tubes 1 \times diameter, all burst.
	V	Glucose, 15 per cent.	4 p.m. 40 per cent. germinated, tubes 3 \times diameter, nearly all burst.
	VI	Nectar from female flower, Tree IV, Nasinu.	4 p.m. no change. May 14th, 9. am. no germination.
	VII	Bees honey	May 14th, 9 a.m. no germination.

Twenty-five per cent. saccharose showed 60 per cent. germination after 6 hours. Fifteen per cent. glucose showing 40 per cent. germination after the same period of time, and both the honeys none at all. This proves that the nectar secreted by the female flowers is certainly a different fluid to that which moistens the stigmas and in which pollen does germinate. As the nectar is sipped away as a rule by insects: bees, hornets, ants, &c., and is probably only meant to attract these insects which in turn, assist in pollination.

The next series of tests were made with pollen kept:—

- A.—In a dessicator with CaCl_2 in light.
- B.—In a dessicator with CaCl_2 in dark.
- C.—In a hermetically sealed tube (rubber stopper) in light.
- D.—In a hermetically sealed tube (rubber stopper) in dark.
- E.—In glass tubes with cork stoppers in light.
- F.—In glass tubes with cork stoppers in dark.
- G.—In dessicator with 50 per cent. sulphuric acid in light.

For germination media 25 per cent. saccharose and 15 per cent. glucose were used. After three days, the first tests were made. The results are shown in the following Table II.

II.—PRESERVATION TEST WITH POLLEN FROM TREE I, NASINU EXPERIMENTAL FARM.

Cut, 12th May, 1926, 2.30 p.m. Shed and collected, 13th May, 1926, 9 a.m.

	Germination fluids.		15/5/26.		17/5/26.		18/5/26.		19/5/26.	
	25 per cent. saccharose.	15 per cent. glucose.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
A1	S	..	% 80	23	% 40	3	% nil	22½	% nil	21½
AII .....	..	G	nil	23	..	..	..	..	..	..
B1	S	..	10	23	10	5	20	22½	2	21½
BII .....	..	G	25	23	..	..	..	..	..	..
C1	S	..	Sporadic	3½	50	5	30	22½	nil	21½
CII .....	..	G	30	3½	..	..	..	..	..	..
D1	S	..	80	23	80	5	20	22½	nil	21½
DII .....	..	G	Sporadic	3½	..	..	..	..	..	..
E1	S	..	80	23	80	22	5	22½	nil	21½
EII .....	..	G	10	23	..	..	..	..	..	..
F1	S	..	25	3½	5	5	..	..	..	..
FII .....	..	G	10	23	..	..	..	..	..	..
G1	S	..	80	2½	10	22	30	22½	6	21½
GII .....	..	G	nil	23	..	..	..	..	..	..

The results showed that the 15 per cent. glucose had never more than 30 per cent. germination. In consequence, this fluid as a germination medium was abandoned in further tests. The 25 per cent. saccharose test showed 80 per cent. germination in cases of D and E after five days, and 30 per cent. in cases of C and G after six days. It was found also that pollen which was preserved in a dessicator with 50 per cent. sulphuric acid maintained a higher germination percentage, than the pollen which was kept in a hermetically sealed tube.

Here an explanation is necessary, as it is evident that pollen, in order to keep a high vitality for a longer period than under ordinary conditions, required stability of atmospheric conditions. Now if pollen is gathered on different days with a different humidity and atmospheric pressure, it is evident that the air closed up in hermetically sealed tubes will be just as different. These conditions very likely are not optimum for coconut pollen. To me this suggests that a dessicator with 50 per cent. H_2SO_4 , which has not a strong dessicating influence, is able to offer a permanent homogenic condition of atmosphere. A quick opening and closing of this dessicator has little effect on the humidity.

So far, pollen gathered from palms growing at Nasinu, or Tokalau, was used for these germination tests, these trees all being in a very poor condition. The average yield never exceeded 12 nuts a year. The reasons for this poor yield were lack of cultivation, ravages committed by the *Levuana* moth in past years, and ravages by other moths which attack the flowers, mentioned elsewhere. The palms do not produce one spathe a month regularly, and these, when produced, are subjected to the attacks by the Spathe Boring Moth, *Acritocera negligens*, and another flower destroying moth, *Tirathaba trichogramma*, and in the course of these attacks, both male and female flowers suffer considerably.

In order to find out whether the bad conditions that prevail have any effect on the vitality of the pollen that they produce, a test was made with pollen taken from a very healthy tree, one which had escaped from the activities of these insect pests, and which had an average yearly yield of, say, 80 nuts, and is growing in the centre of Suva, in a private garden. The results from the test made on this palm will be shown below under tree labelled S.

In the meanwhile further tests were carried out with pollen taken from trees growing at Nasinu—this pollen was kept in dessicators:—

- A.—With $CaCl_2$ in light.
- B.—With $CaCl_2$ in dark.
- C.—With $Ca O$ in light.
- D.—With $Ca O$ in dark.
- E.—With 50 per cent. H_2SO_4 in light.
- G.—With 50 per cent. H_2SO_4 in dark.

III.—GERMINATION TEST WITH POLLEN FROM TREES IV
AND V AT NASINU EXPERIMENTAL FARM.

In 25 per cent. saccharose solution (not sterilised). Cut,
11th June, 1926. Shed and collected, 12th June,
1926, 2 p.m.

	16/6/26.		17/6/26.		18/6/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
A IV	% nil	22	% ..	..	% ..	..
A IV	nil	22	..	..	..	..
A V	nil	22	..	..	..	..
A V	nil	22	..	..	..	..
B IV	nil	22	..	..	..	..
B IV	5	6½	..	..	..	..
B V	nil	22	..	..	..	..
B V	1	6½	..	..	..	..
C IV	nil	22	..	..	..	..
C IV	nil	22	..	..	..	..
C V	nil	22	..	..	..	..
C V	nil	22	..	..	..	..
D IV	nil	22	..	..	..	..
D IV	nil	22	..	..	..	..
D V	nil	22	..	..	..	..
D V	nil	22	..	..	..	..
E IV	80	22	13	22	nil	25
E IV	80	22	20	22	nil	25
E V	90	22	3	22	1½	25
E V	90	22	3	22	nil	25
G IV	nil	22	..	..	..	..
G IV	1	22	..	..	..	..
G V	nil	22	..	..	..	..
G V	nil	22	..	..	..	..

The table shows that after four days keeping B gave in one instance a germination of 5 per cent. while A, C, and D did not germinate. E gave 80 per cent. germination for one tree and 90 per cent. for the other. Further this test demonstrated the fact that *coconut pollen requires light to keep alive*, and full daylight at that.

Nearly all former tests were made in 25 per cent. cane sugar solution, which was occasionally renewed, but not for all tests. As these solutions were not sterilised, they developed bacteria, or moulds which was very often obstructive to proper observation through the microscope. Therefore all further tests were made with a solution of 25 per cent. saccharose and 1½ per cent. gelatine, as recommended in Botanical Handbooks. This solu-

tion was *sterilised* and kept in small containers, holding only 1c.c.m. so that only a small quantity need be in use at the same time. Blank tests showed that if properly treated, the solution in each container could be used for three days without developing moulds. I use every quantity only two days to be certain.

The next test was made with pollen from the above mentioned good tree, S, and from two other trees from Nasinu which were comparatively poor trees, and which were numbered N I and N III, as shown in Table IV:—

IV.—PRESERVATION TEST WITH POLLEN FROM TREE S AND TWO TREES, NASINU EXPERIMENTAL FARM, I AND III.

All pollen kept in daylight.

Germination fluid was 25 per cent. saccharose plus $1\frac{1}{2}$ per cent. gelatine (sterilised).

S 19/6 was cut 18/6 and collected 19/6, kept in dessicator 50 per cent. H_2SO_4 .

S 19/6 XX is control test.

S 20/6 was cut 18/6 and collected 20/6, kept in dessicator 50 per cent. H_2SO_4 .

S 20/6 XX is control test.

NI 20/6 was cut 19/6 and collected 20/6, kept in dessicator 50 per cent. H_2SO_4 .

NI 20/6 XX is control test.

NIII 20/6 was cut 19/6 and collected 20/6, kept in dessicator 50 per cent. H_2SO_4 .

NIII 20/6 XX is control test.

	22/6/26.		23/6/26.		24/6/26.		25/6/26.		26/6/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
S 19/6	40	21	85	23	80	21	70	23	85	$3\frac{1}{2}$
S 19/6	70	21	85	23	80	21	75	23	75	$3\frac{1}{2}$
S 20/6	1?	21	80	23	75	21	*	23	..	..
S 20/6	85	21	75	23	80	21	*	..	..	..
S 19/6 XX.....	..	..	..	..	3	4	1	6	nil	24
S 19/6 XX.....	..	..	..	..	5	21	1	6	nil	24
S 20/6 XX.....	75	21	25	23	5	21	8	6	2	$3\frac{1}{2}$
S 20/6 XX.....	80	21	24	23	8	21	6	6	3	$3\frac{1}{2}$
NI 20/6	75	21	55	23	45	21	35	23	17	$5\frac{1}{2}$
NI 20/6	70	21	65	23	25	21	35	23	15	$5\frac{1}{2}$
NIII 20/6	5	21	22	23	35	21	35	23	28	24
NIII 20/6	30	21	18	23	53	21	60	23	25	24
NI 20/6 XX ...	..	..	..	..	..	..	25	23	21	24
NI 20/6 XX ...	..	..	..	..	..	..	25	23	24	24
NIII 20/6 XX .	..	..	..	..	..	..	33	23	23	24
NIII 20/6 XX .	..	..	..	..	..	..	30	23	26	24

* Pollen supply exhausted.

Continued :—

	27/6/26.		28/6/26.		29/6/26.		30/6/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
S 19/6	80	23	80	8 $\frac{1}{2}$	55	23	25	23
S 19/6	78	23	80	8 $\frac{1}{2}$	50	23	35	23
S 20/6 .....	..	..	..	..	..	..	..	..
S 20/6 .....	..	..	..	..	..	..	..	..
S 19/6 XX .....	..	..	..	..	..	..	..	..
S 19/6 XX .....	..	..	..	..	..	..	..	..
S 20/6 XX .....	..	..	..	..	..	..	..	..
S 20/6 XX .....	..	..	..	..	..	..	..	..
NI 20/6 .....	*	..	..	..	..	..	..	..
NI 20/6 .....	*	..	..	..	..	..	..	..
NIII 20/6 .....	*	..	..	..	..	..	..	..
NIII 20/6 .....	*	..	..	..	..	..	..	..
NI 20/6 XX ...	15	23	3	6 $\frac{1}{2}$	..	..	..	..
NI 20/6 XX ...	22	23	5	6 $\frac{1}{2}$	..	..	..	..
NIII 26/6 XX .	nil	23	..	..	..	..	..	..
NIII 20/6 XX .	nil	23	..	..	..	..	..	..

* Pollen supply exhausted.

The results were that pollen from tree S, had a germination of 80 per cent. after 10 days, while a control test kept under ordinary conditions in a glass tube closed with cotton wool with the same pollen had not even 50 per cent. five days before. The pollen from both of the Nasinu trees had a much lower germination five days earlier, which induces me to believe that pollen drawn from trees in good condition have a higher vitality which is maintained for a longer period, than pollen from trees in a poor condition. Furthermore, pollen from a tree of high vitality is quicker in germinating and forms much longer pollen tubes, while pollen from poorer trees takes hours longer in germinating, forms tubes only several times the diameter of the pollen, and shows a weaker intine, which is shown by a high percentage of pollen bursting before, or while germinating.

I need hardly add, in view of the above, that a careful selection must be made, and only pollen from trees in a first class condition should be used to obtain the maximum results. It is clear also, that no pollen should be used for pollination, which has not been thoroughly tested.

The question still remained, whether 50 per cent. was the most favourable concentration for the sulphuric acid in the dessicator and a test was made with the pollen taken from the poor trees of Nasinu, and were kept in dessicators with 40, 50, and 60 per cent. H₂SO₄. This showed that the neutral test had a germination of 80 per cent. after 6 days. Thereafter, this went rapidly down, and was practically nil after 8 days. The same pollen kept in a hermetically sealed tube, showed 70 per cent. germination after 8 days, and only 8 per cent. on the ninth day, while that from the

50 per cent. H₂S O₄ dessicator showed 12½ per cent. after 8 days, and only 1 per cent. on the ninth day. However, the pollen from the 40 per cent. H₂S O₄ dessicator had fully 80 per cent. germination on the eighth day, and still showed a 20 per cent. germination on the tenth day.

V.—PRESERVATION TEST WITH POLLEN FROM TREE VII, SPATHE 7, ON NASINU EXPERIMENTAL FARM.

The spathe was cut whole and placed in water, 25/6/26, 3 p.m.

Pollen shed and collected, 26/6, 9 a.m.

NVII 26/6 XX under ordinary conditions.

NVII 26/6 XX in tube with rubber cork hermetically sealed.

NVII 26/6 XX in dessicators with 60, 50, and 40 per cent. H₂SO₄.

	26/6/26.		27/6/26.		30/6/26.		1/7/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
N VII 26/6, 40% dessicator	90	..	90	..	90	22	82	4½
Do. do.	90	..	..	..	90	22	85	5½
N VII 26/6, 50% dessicator ....	..	..	..	..	..	..	..	..
Do. do. ....	..	..	..	..	..	..	..	..
N VII 26/6, 60% dessicator ....	..	..	..	..	10	22	6	22
Do. do. ....	..	..	..	..	12	22	8	22
N VII 26/6 XX	95	6	90	6	80	22	80	8
Do.	95	6	90	6	70	22	82	10
N VII 26/6 rubber stopper ....	..	..	..	..	..	..	..	..
Do. do. ....	..	..	..	..	..	..	..	..

Continued :—

	2/7/26.		3/7/26.		5/7/26.		6/7/26.	
	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.	Per cent. germination.	Duration of test in hours.
N VII 26/6, 40% dessicator	80	22	80	22	25	6	20	22
Do. do.	80	22	80	22	25	6	18	22
N VII 26/6, 50% dessicator ....	..	..	15	6	2	6	..	..
Do. do. ....	..	..	10	6	1	6	..	..
N VII 26/6, 60% dessicator	6	22	5	22	1	22	..	..
Do. do.	4	22	3	22	1	22	..	..
N VII 26/6 XX	55	22	45	6	..	22	..	..
Do.	45	22	40	6	1	22	..	..
N VII 26/6 rubber stopper ....	..	..	75	8	10	22	..	22
Do. do. ....	..	..	65	8	8	22	..	22

The natural conclusion to be drawn from this test is that 40 per cent. sulphuric acid had a more favourable influence on this particular pollen than 50 per cent. sulphuric acid. Not being satisfied with the results of preserving pollen in a dessicator with 40 per cent. sulphuric acid I made further tests to find out whether a lower percentage would prove better. Thirty per cent. proved to be slightly more satisfactory, but 20 per cent. was entirely unsatisfactory. Sometimes however 40 per cent. was better than 30 per cent.

These facts suggest that 30 and 40 per cent. are both situated not far from the top of a curve, while the optimum per cent. is somewhere between 30 and 40. (See Table VI.)

VI.—COMPARATIVE TESTS WITH POLLEN KEPT IN DESSICATORS RESPECTIVELY, HOLDING 40, 30, AND 20 PER CENT. H_2SO_4 (D5, 2/10/26).

The Pollen used was from Malayan Dwarf.

Date of tests.	Duration of test in hours.	Age of pollen used.	Germination in per cent. of Pollen from the Dessicator with H_2SO_4			Lengths of Pollen Tubes.			Temperatures.			
			40%	30%	20%				7 p.m.	Noon.	5 p.m.	Max.
7/10	A 7	5	95	90	50	10-12	10-12	10-12	77	83	77	85
	B 7	5	90	90	40	10-12	10-12	10-12	..	..	..	..
9/10	A $8\frac{1}{2}$	7	45	85	42	8-12	8-12	6-8	75	83	79	85
	B $8\frac{1}{2}$	7	50	70	30	8-12	6-10	4-6	..	..	..	..
10/10	A $10\frac{1}{2}$	8	80	75	5	10-12	10-14	3-5	75	$83\frac{1}{2}$	76	86
	B $10\frac{1}{2}$	8	85	85	30	10-12	12-16	10-15	..	..	..	..
11/10	A 8	9	85	85	2	4-10	6-10	5-12	$73\frac{1}{2}$	82	80	$86\frac{1}{2}$
	B 8	9	85	75	1	4-10	6-10	2-4	..	..	..	..
12/10	A $8\frac{1}{2}$	10	75	80	..	4-10	12-16	..	72	81	$76\frac{1}{2}$	86
	B $8\frac{1}{2}$	10	70	80	..	6-12	12-16	..	..	..	..	..
13/10	A	*	..	..	..	..	..	..	..	..	..	..
	B	*	..	..	..	..	..	..	..	..	..	..

* Pollen exhausted.

Further tests were made with germination solutions, containing besides 25 per cent. saccharose, $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent. gelatine. Thus far only the solution with $1\frac{1}{2}$ per cent. gelatine had been used. The effect on the germination of pollen, especially on the growth and the length of the pollen tubes is obvious. The test which was made with pollen of a very good Malayan Dwarf and a very good Niu Leka, was a combination of preservation in a dessicator with 30 and 40 per cent. of sulphuric acid and germination in the sugar solutions containing $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent. gelatine.

Nearly all through the tests which lasted 16 days for each pollen variety, $4\frac{1}{2}$ per cent. gained on 3 and $1\frac{1}{2}$ per cent., but especially when the pollen was getting older. Four and a half per cent. gelatine stimulated the pollen not only to germinate, but also to grow much longer pollen tubes, and it can be seen that pollen germinated with $1\frac{1}{2}$ per cent. gelatine grew tubes from $3-12 \times$ diameter of the pollen, and the same pollen germinated with $4\frac{1}{2}$ per cent. gelatine formed tubes as long as $22 \times$ diameter of the pollen. In many cases the tubes were as long as $35 \times$ diameter of the pollen grain.

See Tables VII and VIII.

VII.—TEST WITH POLLEN FROM A MALAYAN DWARF K. B.8 11/10 WHICH WAS KEPT IN DESSICATORS RESPECTIVELY WITH 30 AND 40 PER CENT. H_2SO_4 AND GERMINATED IN 25 PER CENT. SACCHAROSE SOLUTIONS, HOLDING RESPECTIVELY $1\frac{1}{2}$, 3, AND $4\frac{1}{2}$ PER CENT. GELATINE.

Date of test.	Age of pollen.	Duration of test in hours.	Per cent. of H_2SO_4 used in dessicator.	Per cent. germination in 25 per cent. saccharose and $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent. gelatine.				Lengths of tubes in $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent.			Temperatures.			
											7 a.m.	Noon.	5 p.m.	Max.
17/10	6	$22\frac{1}{2}$	$\frac{\%}{40}$	$\frac{\%}{80}$	$\frac{\%}{75}$	$\frac{\%}{80}$	-20	12-16	-40	76	87	78	87	
	..	$22\frac{1}{2}$	40	80	75	80	-20	12-16	-30	..	..	..	..
	..	$22\frac{1}{2}$	30	90	80	90	-20	-20	-40	..	..	..	..
	..	$22\frac{1}{2}$	30	90	70	90	-20	-20	-40	..	..	..	..
19/10	8	13	40	70	80	80	-20	-24	-30	75	82	$76\frac{1}{2}$	84	
	..	13	40	40	75	75	-12	-20	-24	..	..	..	..
	..	13	30	60	85	60	-12	-24	-13	..	..	..	..
	..	13	30	80	85	50	-20	-24	-24	..	..	..	..
21/10	10	11	40	80	70	70	-20	-10	-24	71	80	74	81	
	..	11	40	50	8	70	-12	-8	-24	..	..	..	..
	..	11	30	80	60	60	-16	-18	-18	..	..	..	..
	..	11	30	75	30	65	-16	-8	-20	..	..	..	..
23/10	12	$10\frac{1}{2}$	40	50	85	85	10-14	12-20	20-30	$75\frac{1}{2}$	78	75	83	
	..	$10\frac{1}{2}$	40	60	75	75	12-18	12-20	20-25	..	..	..	..
	..	$10\frac{1}{2}$	30	80	90	70	14-20	20-35	15-25	..	..	..	..
	..	$10\frac{1}{2}$	30	80	85	80	12-20	20-30	15-25	..	..	..	..
24/10	13	$9\frac{1}{2}$	40	15	30	20	3-15	-18	-16	$76\frac{1}{2}$	82	80	83	
	..	$9\frac{1}{2}$	40	20	20	40	3-15	-8	-21	..	..	..	..
	..	$9\frac{1}{2}$	30	..	20	35	..	-20	-18	..	..	..	..
	..	$9\frac{1}{2}$	30	2	15	30	3 x	-10	-20	..	..	..	..
25/10	14	$11\frac{1}{2}$	40	20	25	60	-14	-12	-16	77	85	$82\frac{1}{2}$	87	
	..	$11\frac{1}{2}$	40	50	25	65	-20	-12	-18	..	..	..	..
	..	$11\frac{1}{2}$	30	15	28	65	4-8	-7	-22	..	..	..	..
	..	$11\frac{1}{2}$	30	60	40	60	-20	-8	-20	..	..	..	..
27/10	16	$13\frac{3}{8}$	40	5	30	60	1-2	4-18	6-22	$72\frac{1}{2}$	83	79	84	
	..	$13\frac{3}{8}$	40	12	35	60	6-17	8-22	6-22	..	..	..	..
	..	$13\frac{3}{8}$	30	15	50	30	4-16	8-26	6-21	..	..	..	..
	..	$13\frac{3}{8}$	30	15	10	35	4-16	3-19	6-21	..	..	..	..

VIII.—TEST WITH POLLEN FROM A FIJIAN DWARF (NIU LEKA) N.L.Co 16/10 WHICH WAS KEPT IN DESSICATORS RESPECTIVELY WITH 30 AND 40 PER CENT. H_2SO_4 AND GERMINATED IN 25 PER CENT. SACCHAROSE SOLUTIONS, HOLDING RESPECTIVELY $1\frac{1}{2}$, 3, AND $4\frac{1}{2}$ PER CENT. GELATINE.

Date of test.	Age of pollen.	Duration of test in hours.	Per cent. of H_2SO_4 in dessicator.	Per cent. germination in 25 per cent. saccharose and $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent. gelatine.				Lengths of tubes in $1\frac{1}{2}$, 3, and $4\frac{1}{2}$ per cent.			Temperatures.			
												7 p.m.	Noon.	5 p.m.	Max.
22/10	6	24	40	60	20	80	-18	-14	20-35	71	80	77	82	
	..	24	40	60	30	85	-18	-14	20-35	..	..	..	..
	..	24	30	60	70	85	-14	-16	20-30	..	..	..	..
	..	24	30	70	80	80	-16	-20	20-30	..	..	..	..
24/10	8	10	40	60	80	80	-15	-20	-21	76 $\frac{1}{2}$	82	80	83	
	..	10	40	40	55	72	-15	-16	-20	..	..	..	..
	..	10	30	60	80	65	-15	-17	-24	..	..	..	..
	..	10	30	30	90	55	-9	-19	-21	..	..	..	..
	..	10	30	30	90	55	-9	-19	-21	..	..	..	..
26/10	10	12 $\frac{3}{4}$	40	35	5	40	-13	-4	-18	78	83	78	84	
	..	12 $\frac{3}{4}$	40	5	60	55	1-2	-15	-20	..	..	..	..
	..	12 $\frac{3}{4}$	30	8	50	65	-6	-22	-22	..	..	..	..
	..	12 $\frac{3}{4}$	30	75	50	75	-18	-20	-22	..	..	..	..
28/10	12	13	40	3	60	60	2-4	6-20	5-22	76	84	80	86	
	..	13	40	35	40	60	6-16	3-18	5-22	..	..	..	..
	..	13	30	40	65	35	3-20	8-20	6-22	..	..	..	..
	..	13	30	35	55	55	3-15	4-17	6-24	..	..	..	..
29/10	13	13	40	35	55	70	4-13	4-18	6-22	78	85	80	87	
	..	13	40	35	65	72	5-12	6-18	6-24	..	..	..	..
	..	13	30	40	60	60	4-14	6-20	6-24	..	..	..	..
	..	13	30	35	64	50	4-12	6-22	6-20	..	..	..	..
30/10	14	13	40	12	25	16	3-14	6-20	3-11	75	80	75	80	
	..	13	40	15	20	30	6-17	6-18	4-18	..	..	..	..
	..	13	30	25	22	40	3-12	4-16	6-20	..	..	..	..
	..	13	30	30	20	40	4-16	4-12	6-20	..	..	..	..
1/11	16	12 $\frac{3}{4}$	40	8	15	6	3-12	3-17	3-24	76	79	77	82	
	..	12 $\frac{3}{4}$	40	8	25	8	3-12	5-23	4-32	..	..	..	..
	..	12 $\frac{3}{4}$	30	12	35	18	3-14	3-22	4-18	..	..	..	..
	..	12 $\frac{3}{4}$	30	22	35	5	3-18	3-22	4-10	..	..	..	..

Thus it is possible to keep 35 to 60 per cent. of pollen viable during at least 16 days in dessicator with from 30 to 40 per cent. sulphuric acid. This will enable us to carry out pollinations with pollen from trees growing on islands in this group far away from the mother trees. The pollen has then to be carried in special dessicators, so that shaking does not bring the sulphuric acid in contact with it while continually kept in full daylight.

Tests carried out with pollen taken from the first spathe of coconut trees gave no germination at all, which confirms the general opinion, that pollen from the first spathe of a tree is sterile. The first spathe has never been found to bear female flowers.

POLLINATING AGENTS.

While examining a spadix in bloom one will be astonished to find a large number of different insects visiting both the male and female flowers. Among the visitors must first of all be mentioned the hornet, further the domestic bee, a much smaller wild native bee, a small fly, a green beetle known as Japanese rose beetle, different sorts of ants, earwigs and a red and black wasp. Other regular visitors are lizards and a very small bird. Specimens of all the insects were examined and it was found that only the two sorts of bees and the little fly carried coconut pollen.

Several bees caught on the wild flowers growing under the trees were examined for pollen but the bees taken from the sensitive grass (*Mimosa pudica*) nearly always carried pollen of these flowers only. The same was found with bees visiting the blue rat-tail (*Stachytarpheta*), Koster's curse (*Clidemia hirta*), *Lantana camara*, and a *Malva* variety. Sometimes I found a few of these pollens mixed, but never did I detect any weed pollen among the coconut pollen. The flowers of these weeds are all on practically the same level over the ground.

Bees visiting coconut trees apparently find sufficient work there, not to be bothered with other plants. This is perhaps a matter of specialising in collecting only one sort of pollen. It is the pollen which they carry in the hairs on the body which comes on the stigmas, not the pollen they carry in cakes in the baskets on their legs. It is a certain fact that bees, which have been visiting male flowers for pollen and nectar, also visit female flowers for nectar, and in going from one drop of nectar to the other two, on the same female flower, they cross the stigmas and thus actually pollinate them. Often in certain positions of the female flowers, the nectar drops grow too large and run over the stigmas. Bees may be seen cleaning such nectar from the stigmas, thus helping the pollen which is left on them to germinate and deterring destruction by the nectar.

The hornets, by some authors supposed to assist in pollinating, do not carry pollen, although they have a few hairs on the legs. They only rob the flowers of pollen and honey, and prey on the bees and ants and other insects. In keeping the bees away from the flowers, hornets do much harm. The bees which certainly assist in pollinating the stigmas are as a rule not very numerous on coconut plantations, and the hornets who are only robbers prevent even these few from doing their valuable work.

I do not think that ants help in pollinating. If they carried pollen at all, they could only deposit it on the stigmas of the same spadix, as they do not travel from one tree to another. I have often noticed ants walking over the stigmas notwithstanding the secretion from the numerous pores round the stigma, which according to Petch form a ring of fluid around them keeping the ants away.

On Taveuni, where there are so many rain-days, and besides many days of dull weather, the bee as a pollinator is essential to the coconut cultivation. More bees and fewer hornets would undoubtedly have a favourable influence on the nut production.

The abundant production of honey and pollen point undoubtedly to insect pollination as does the scent spread by the honey. But on the other hand the enormous number of male flowers compared with the number of female flowers and the extremely large quantity of pollen which, at the least puff of wind spreads in clouds of dry powder through the air, are an indication

for wind pollination. V. C. Aldaba in the Philippines proved by experiments that comparatively few pollen grains reach the stigmas, when pollinated by the wind. However, the wind must be held responsible for most of the pollinations which occur on dull and rainy days when very few insects are about.

SELF-POLLINATION.

Self-pollination of coconuts takes place if pollen of a spathe pollinates the stigmas of the flowers of that same spathe or if pollen of a certain spathe pollinates the stigmas of the flowers of another spathe of that same tree. It will not be difficult to see that the first case is only possible if the male phase overlaps the female phase of the same spathe. This is really the case with the Malayan Dwarfs but not with Niu Lekas. The second case would be possible if pollen of a certain spathe was being shed while the preceding spathe has still receptive female flowers. This, however, has not yet been observed by me. It does happen with Niu Lekas that a spathe opens before the female phase of the preceding one is ended, but as it takes from 7 to 10 days before the male phase of the new spathe begins the female phase of the old spathe by that time is well finished. Thus self-pollination between them is impossible.

It is mentioned by Dr. Hunger in his book "*Cocos nucifera*" that Dr. P. van der Wolk had success in Java with self-pollinating and according to H. W. Jack it is the rule in the Federated Malay States. This author, however, does not tell how he arrives at this conclusion.

Trials were made with artificial self-pollination by me on Malayan Dwarfs on Mua plantation in Taveuni. A spathe was emasculated just before the female phase set in and the pollen thus cut off was collected and preserved and used for pollinating the stigmas, but at first without any results. After that a spadix was bagged with branches and all, and the male flowers left to open in the bag. Part of the pollen fell out of the anthers but as there was no wind inside the bag, most of it remained in the male flowers. Therefore the branches were shaken so that much pollen fell on the stigmas. This time some results were obtained but much fewer than were expected. As no insects could enter the bag and no honey was taken away a very sticky condition of spadix and bag resulted. More trials were made by applying emasculation and better results ensued. Considering that everything was done to facilitate selfing, the results were rather poor and it seems to me that uncontrolled, natural selfing, at least in Fiji, is not the rule with Malayan Dwarfs.

CROSS POLLINATION.

When inspecting different coconut plantations it will be found very difficult, if not impossible, to detect two trees alike or nearly alike. There are nearly as many types of coconuts as there are trees and this fact points very strongly to cross pollination. It is possible to classify them as tall and dwarfs, late-bearing varieties and early-bearing, also as red, green and yellow nut bearing trees, but for the rest there is nothing which justifies a grouping in a limited number of varieties.

No intentional breeding has been done in Fiji so far and the seed used for planting the existing plantations was taken from close by without considering the origin. Only in a few instances has seed been selected so far. Sometimes only large nuts have been planted or nuts only from heavy bearing trees, but it is obvious that even the best selected seed is of unknown parentage, at least on the male side. Besides, many a traveller has brought

nuts from Samoa, Tonga, Rotuma and other places, from trees which for some reason or other struck his fancy, and planted them between tall coconuts or Niu Lekas on his plantation. Later the man has sold his property and the next owner has known nothing of these imported trees if he ever detected them. Where such conditions prevail the seed material is very variable and unsuitable for planting up new plantations. Uncontrolled cross pollination must be considered the rule in these islands and the cause of the existing conditions.

ARTIFICIAL POLLINATION.

In order to obtain reliable seed material, pollinating has to be controlled and this can be done by artificially pollinating the stigmas with pollen of known and selected trees.

PREPARATIONS.

In order to perform artificial pollinations certain preparations have to be made, to keep insects at a safe distance, also to prevent undesirable pollen from coming in contact with the stigmas. Therefore all the male flowers must be removed not forgetting the ones situated alongside the female flowers. The branchlets are cut off about half an inch above the female flowers with secateurs or a sharp knife, so that the cut wounds are very clean. As far as my observations go, emasculation has no visible effect on the growth of the female flowers nor does it cause any damage to the spadix in general. It must be understood that the male flowers may remain on the spadix until a few days before the female phase begins. This can be estimated fairly accurately within two or three days. Emasculation being done the spadix must be thoroughly cleaned, and all diseased or half eaten flowers, also borers and borer dirt, earwigs, ants and any other insects must be removed. To prevent interference from insects a bag must be fastened around the spadix. If ants are to be kept from entering the bag during the receptivity of the female flowers, tanglefoot may be applied around the stalk outside the bag.

It was found in connection with the shape of the coconut trees, also the lengths and placing of the spadices, that it was best to make the bags from 10 to 12 inches wide and from 3 to 3½ feet long. Further, it was necessary to open and close the bags quickly in order to perform the pollinations and make observations, without removing them. A suitable bag was constructed in which two copper rings of 10 to 12 inches diameter run through small brass rings, in order to hold the bag open. An overlap of 6 inches is sufficient to prevent insects entering. The bottom end of the bag is fastened around the clean stalk of the spathe while the top is tied to at least three midribs of leaves.

To make the placing and fastening of the bag easier the female flowers of the two or three lowest branchlets are removed. These flowers, as a rule, are smaller and a little backward and obstruct the proper fastening of the bag around the stalk. I tie this end of the bag with a thin sail-maker's string, taken double, which though rather expensive, proves to be cheap in the long run, because it can be used for several months on different spathes in all weather without deteriorating. The overlap is fastened with enough pins to keep insects out.

To open the bag in order to examine the spadix or to pollinate, the flap, after removing the pins, is pushed to the right while the other edge is pushed to the left, the small rings sliding easily over the copper-wire rings. The

opening must not be wider than necessary, and if there is wind which may be disturbing to the act of pollinating, or carry foreign pollen inside the bag, and perhaps on the stigmas, it is advisable to shut the wind out by opening only one side of the bag. The bag should be fastened in such a way that the opening comes on the ventral side of the spathe, that is the side facing the subtending leaf. An advantage of this type of bag is that the original shape and position is retained after opening and closing. I have been using this type of bag for fifteen months, and find it very satisfactory.

According to Dr. P. van der Wolk it is possible to cause the female flowers to ripen earlier than usual just by covering them with black paper. Perhaps the application of a white cotton bag has a similar effect on the female flowers, although such a bag does not keep the flowers in the dark. But if the flowers are speeded up in becoming receptive as a result of the bag this can be only an advantage because the pollen can then be used somewhat sooner.

POLLINISING.

Stigmas can be artificially pollinated with a No. 1 camel hair brush. The smallest possible quantity of pollen is taken with the brush from the glass tube and carefully placed on the moist narrow ribs of the stigma. Sometimes it is necessary to repollinate a few stigmas after the whole spadix is done, because one cannot avoid shaking the spadix and knocking some of the pollen from the pollinated stigmas.

If the distance from laboratory to the field may be traversed in no more than half an hour the glass tubes containing the pollen may safely be taken from the dessicator, and quickly closed with a well fitting cork stopper and so carried to the trees, but if the distance requires more than half an hour it is advisable to close the tubes with paraffined or rubber stoppers.

For long distance the pollen will have to be transported in a special dessicator, of such a construction that shaking cannot bring the sulphuric acid in contact with the pollen. The following construction proved rather suitable: A Wolff bottle with two necks is half filled with the required 35 per cent. sulphuric acid solution while two thin glass tubes bent at right angles fit in two rubber stoppers in the bottle. Two wide glass containers holding the small tubes with pollen are also fitted with rubber stoppers and thin glass tubes bent at right angles while pieces of rubber tubing connect the glass tubes. The rubber tubing can be pressed together with metal clips, so that no sulphuric acid can pass through. The whole is placed in a wooden box with glass walls and a handle on top. When the atmospheric condition in the glass containers is the same as in the Wolff bottle the clips are placed on the rubber tubing and the dessicator can stand much shaking without any danger.

AVAILABLE VARIETIES.

The varieties of coconuts on which I was to experiment on Mr. F. Duncan's plantation, Mua, on Taveuni, were the so-called Malayan Dwarf, an imported variety from the Federated Malay States, and the Fijian Dwarf or Niu Leka. The trees were planted in January, 1922, and it was in August, 1925, that the first tree commenced flowering. In August, 1926, there were 48 trees flowering, and in bearing, of which 21 were selected for experiments.

There are two types of Malayan Dwarf: one with apricot coloured nuts and a yellow or reddish hue all over the spathe stalks, and mid-ribs, and another with slightly smaller, greenish or ivory-yellow nuts, and a paler

green colour in stalks and mid-ribs. Of the latter type only one tree was used for experiments. The nuts of both types have the same shape—that is, round on transverse section and oblong on longitudinal section, slightly pointed at both ends.

In an essay on Dwarf Coconuts in the "Malayan Agricultural Journal," Vol. XII, No. 11, November, 1924, H. W. Jack points out that there are three distinct types of Malayan Dwarf, apricot, green and ivory-yellow. "These Malayan Dwarfs are locally known in Malaya as Niur gading, and are supposed to have been imported from Java, district Krian." Further on he writes: "On existing plantations these types are intermingled with each other and with ordinary tall and semi-talls though the ivory-yellow type predominates." The Malayan Dwarf could, except for the three colours in nuts, be called a pure line.

The Niu Lekas, however, is a group, or population, with distinct types, although all are more or less early bearing. It may be possible to divide these Niu Lekas according to colour, and shape of the nuts and the diagrams of the spathes into groups. Though these groups are certainly not pure lines, through breeding from distinct types only and by keeping them well isolated, it may be possible to obtain very useful material for crossing with other good types, or with imported strains.

There are many types among the Niu Leka with rather short leaves, though the majority have heavy mid-ribs with a broad foot gripping round the stem of the tree. The general appearance of the crowns is heavy and dense, but strong. However, a few trees can be found with slightly longer leaves, thinner mid-ribs and a much more open crown, with long spathes, being at the same time fairly heavy producers.

The inflorescences of the Niu Lekas differ in many ways from those of the Malayan Dwarfs. Not only are there red and green nuts, round and long shaped nuts, trees with heavy dense crowns, and trees with open, airy crowns, long leaves with thin mid-ribs and short leaves with very heavy and broad mid-ribs, but all these types have variable inflorescences.

The diagrams show some of the variations very plainly. The number of branchlets of the spadices varies from 49 to 76. Some trees have never more than one female flower per branchlet—others have no female flowers on the first 10 to 14 branchlets. Again others have very few female flowers on the lower branches, or very few on the top branches. Or one spadix may have 58 branchlets all crowded on a stalk 30 inches long, while other trees have only 50 branchlets on stalks of 5 feet in length. In the latter case the nuts will have more room for development and less chance of pushing one another from the stalk.

The shape and size of the female flowers of the Niu Lekas varies greatly. As a rule the stigmas are smaller than those of the Malayan Dwarfs, although the female flower in full receptivity may be larger.

The male flowers of the Niu Lekas are mostly different from those of the Malayan Dwarfs. They are not so pointed as a rule, and placed closer together and very often in pairs. When the branchlets are very short, and the number of flowers large, they are so crowded together that they take a shape according to the space they have to develop in. In general, the Niu Lekas have more male flowers on a branchlet than the Malayan Dwarfs, and the branchlets also are more numerous; consequently, there is a greater abundance of pollen in the Niu Leka spathe, which makes collecting easier.

Another rather early bearing variety which may prove very useful for breeding purposes is the Rotuma nut. There happened to be a complex of about 40 acres of Rotumas on Mrs. Mackenzie's Plantation, Nagasau on Taveuni, where I was kindly offered the opportunity to make pollination experiments.

The Rotumas bear a larger size nut than the ordinary tall coconut and with thicker meat. In order to breed improved Rotuma stock it will probably be advisable to carry out artificial pollinations on selected superior types on the island of Rotuma, where in all probability the variety has been kept rather pure through the isolation of the island.

On a fourth local variety, the common tall Fiji coconut, no pollination experiments have as yet been carried out. For such a purpose it will be necessary to produce a complex of young trees not too high, kept in so good a condition that very healthy superior types may be selected.

SELECTION OF SUPERIOR TREES.

Breeding superior stock means breeding coconut trees with an average yearly yield of oil higher than the present average. It would take a very long time and much expense to analyse meat of all the good trees on a plantation in order to find the highest yielders, but it is generally taken for granted that a tree with a large number of large nuts with thick kernel will produce a large quantity of oil. This may eventually be found not to be the case. Such an assumption, however, simplifies greatly the selection of trees for breeding. Since the acid test is a large average yield of copra, per acre, trees must be sought which produce a large number of large nuts of a thin husk and a thick kernel, and which lend themselves to close planting. Trees just coming into bearing should not be selected, because an optimum or maximum production is not reached for several years after the first spathe appears, or that, at least, is the general opinion of authors.

When a number of trees of apparent high yield have been selected their relative merits can be more accurately gauged by calculating the theoretical yearly yield of wet copra which would be produced per acre if the trees under consideration were reduplicated in plantations. If all the ripe nuts obtainable for each tree be measured and weighed, and the wet copra cut from such nuts be weighed an average weight of whole nut and an average weight of copra per nut can be obtained for the several trees. To estimate the number of nuts which the several trees would produce in a year all visible nuts of every age should be counted for each tree, that number divided by the number of spadices involved (to get the number per spadix) and then multiplied by twelve (as one spathe is put forth each month). A third factor to be determined is the number of trees of the patterns selected which could be grown per acre of land. The theoretical yearly yield then is the product of these three factors, viz., the average weight of wet copra per nut, the estimated number of nuts per year, and the estimated number of trees per acre.

All these high yielders are subsequently selected on the basis of habitus, shape, density or openness of the crown, length and thickness of the mid-ribs, length of spathe, also number and placing of the female flowers. Here the diagrams of the spadices of each tree are of great help showing numbers, irregularities, if any, and whether a tree tends to "go off" sometimes, as the planters call it, when a tree stops producing female flowers and even spathes temporarily. All the diagrams of the Malayan Dwarfs are alike,

proving that this variety approximates a pure line, which made selecting very easy, because only the healthiest and strongest trees were to be picked. Similar diagrams were made of apparently the best Niu Leka trees, and from the diagrams were chosen those which showed a large number of female flowers with the greatest regularity, and with a tendency to increase the number of female flowers, and to produce more than one female flower on the same branchlet. The same selection was applied to the Rotumans at Nagasau where two superior trees were selected.

The number of trees per acre varies with the variety. The usual distance in Fiji for common coconuts is 30 feet, but many Niu Lekas do not require more than 24 or 25 feet while Malayan Dwarfs on account of the short leaves may be planted at 20 feet.

In the following table the theoretical yearly yields of wet copra per acre are calculated for the trees which were selected for breeding improved stock:—

Coconut variety.	Average total weight per nut.	Average weight of meat per nut.	Average number of nuts per tree.	Yearly yield of wet copra per tree.	Plant distance in feet.	Number of trees per acre.	Theoretical yearly yield wet copra per acre.
Malayan Dwarf ..	lb-oz. 2-12 $\frac{3}{4}$	lb-oz. 0-12 $\frac{3}{4}$	72	lb 57 $\frac{3}{4}$	20	108	lb 6,196 $\frac{1}{2}$
Niu Leka C.o. ..	5- 9	1- 4	90	112 $\frac{1}{2}$	30	48	5,400
Niu Leka E.3. ..	3-15	0-15	106	100	30	48	4,800
Rotuma, Green ..	5-12	1-10	78	126 $\frac{3}{4}$	30	48	6,084
Rotuma, Red ..	4- 2 $\frac{1}{2}$	1- 2 $\frac{3}{8}$	60	70.	30	48	3,360
Common Coconut ..	..	1- 0	42	42	30	48	2,016

These yield figures being obtained by multiplication, are naturally very unreliable and consequently can be used only comparatively. When comparing these yields with those of the average plantation tree, producing 42 nuts per year, and having an average of 1 lb of wet copra per nut, which is probably too high, it will be seen that they are all much higher.

The practice of selecting useful parent trees by sight, even considering the inflorescence and the yearly yield of copra, does not guarantee a uniform plantation. The seedlings of the same parent trees will vary considerably on account of uncontrolled cross pollination. Only by cross pollination or selfing practiced on the parent trees artificially is a more uniform offspring to be expected, although even then the influence of the grand-parents will be noticeable. Intercrossing of the daughter trees is then the means of eliminating undesirable qualities.

POLLINATIONS ON MALAYAN DWARFS.

The few tests which I made around Suva, in 1926, were not satisfactory, as the trees used were in a very poor condition, and the pollen of these trees consequently lacked much in vitality. On Taveuni, conditions are different. The selected Malayan Dwarfs are all rather healthy, and if pollinations could not be made on all available spathes, this was due to much damage

by moths, or to weather conditions. Until the beginning of October, 1925, I was unable to test the different pollens, because the germination solution I took with me from Suva, apparently being too old, did not give satisfactory results. Thus all the pollinations made before that time were made on the off-chance. From 230 pollinated flowers on Malayan Dwarfs during that period, 54, that is 23.5 per cent. became fertilised. They were counted eight weeks or longer after pollinating and it is not likely that any more drops would occur after that period unless caused by injurious insects, rats, crabs, &c. After October, 1925, the pollen used for pollinations was tested as regularly as possible and only pollen of a high percentage of germination in a solution of 25 per cent. saccharose and 4½ per cent. gelatine was used.

Undoubtedly a large number of the failures are the results of pollinating flowers which were not yet fully receptive or already past receptivity. A number of the other failures and probably not the smallest, is due to dull weather on rainy days when the temperature is low.

POLLINATIONS ON NIU LEKAS.

In 1926, on 14 Niu Leka trees, 382 pollinations were made. The flowers were all pollinated with pollen from Malayan Dwarfs. At the end of 1926 nothing could be said with certainty about the results as some of the nuts were still likely to fall. Now all the nuts pollinated in 1926 have been collected during 1927, and of those pollinated in 1927 it can be said of a good many, with certainty, that they will remain on the trees.

The following tables show in light figures the numbers of pollinations made in the different months on the various trees of Malayan Dwarfs, Niu Lekas, and Rotumas. The black figures give the numbers of the resulting nuts and where black figures are absent the number of resulting nuts was not to be told with certainty. However, calculating the probable results at the same rate as the certain nuts, I was able to estimate the probable total of each variety which will be available by the end of 1928, being for Malayan Dwarfs, 289 or 27.25 per cent.; for Niu Lekas, 97 or 34.1 per cent.; and for Rotumas, 42 or 30.9 per cent.:—

TABLE I.—POLLINATION AND RESULTING NUTS THEREOF ON MALAYAN DWARF COCONUTS, MUA ESTATE, TAVEUNI.

Tree.	March.		April.		May.		June.		July.		August.		Sept.	
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.
A6	15	3	11	1	2	0	14	2	..	..	15	7	..	..
B6	37	10	3	0	8	2	9	4	5	2	16	10	..	..
B7	18	4	8	4	15	6	15	8	14	6	..	..	..	..
B8	24	4	16	3	10	..	..	..	..	..	26	..	..	..
D2 .....	..	..	..	..	..	..	3	..	..	..	..	..	13	..
D7	27	6	9	3	..	..	..	..	..	..	19	..	16	..
E3	14	2	..	..	..	..	13	..	..	..	2	..	11	..
E5	18	3	7	..	..	..	..	..	8	..	..	..	6	..

TABLE I—continued :—

Tree.	March.		April.		May.		June.		July.		August.		Sept.	
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.
E 6 .....	..	..	..	..	11	..	..	..	..	..	11	..	8	..
E 7	21	6	..	..	..	..	..	..	..	..	..	..	..	..
F 2 .....	..	..	..	..	..	..	..	..	..	..	..	..	10	..
F 3 .....	..	..	..	..	10	2	..	..	..	..	..	..	9	..
F 7	19	5	..	..	21	3	1	..	15	..	..	..	..	..
G 4	15	6	..	..	..	..	..	..	11	..	..	..	..	..
G 5 .....	..	..	..	..	22	4	7	..	14	..	3	..	..	..
G 6	23	5	..	..	..	..	9	..	12	..	5	..	..	..
G 7	17	1	..	..	..	..	14	5	..	..	27	..	17	..
H 6	19	5	..	..	16	7	..	..	10	..	19	..	..	..
Certain	267	60	47	11	94	24	52	19	19	8	31	17	..	..
Uncertain ....	..	..	7	..	21	..	33	..	70	..	112	..	90	..
Totals	267	..	54	..	115	..	85	..	89	..	143	..	90	..

TABLE I—continued :—

Tree.	October.		Nov.		Dec.		Totals per tree.		Totals of nuts.
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	
A 6 .....	..	..	..	..	12	..	71		.....
B 6	11	0	..	..	11	..	100		.....
B 7	6	..	6	..	11	..	93		.....
B 8	25	..	15	..	..	..	116		.....
D 2 .....	..	..	..	..	..	..	16		.....
D 7	13	..	9	..	..	..	91		.....
E 3 .....	..	..	..	..	..	..	40		.....
E 5 .....	..	..	..	..	..	..	39		.....
E 6	12	..	4	..	..	..	46		.....
E 7	9	..	..	..	18	..	48		.....
F 2 .....	..	..	..	..	..	..	10		.....
F 3 .....	..	..	..	..	..	..	19		.....

TABLE I—continued :—

Tree.	October.		Nov.		Dec.		Totals per tree.		Totals of nuts.
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	
F 7 .....	..	..	..	..	..	..	56		.....
G 4 .....	..	..	..	..	..	..	26		.....
G 5 .....	..	..	11	..	..	..	57		.....
G 6	10	..	..	..	11	..	70		.....
G 7	16	..	10	..	..	..	101		.....
H 6 .....	..	..	..	..	..	..	64		.....
Certain .....	..	..	..	..	..	..	510		139 27 $\frac{1}{4}$ % A
Uncertain	102	..	55	..	63	..	553		150 B
Totals	102	..	55	..	63	..	1,063		289 probable total

TABLE IIa.—POLLINATIONS AND RESULTING NUTS THEREOF ON NIU LEKA COCONUT TREES.
MUA ESTATE, TAVEUNI.

Tree.	March.		April.		May.		June.		July.		August.		Sept.	
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.
Co .....	..	..	..	..	43	11	16	7	21	8	16	..	16	..
E3 .....	..	..	..	..	..	..	..	..	..	..	25	..	22	..
F6	20	3	15	6	11	8	..	..	..	..	..	..	..	..
Certain	20	3	15	6	54	19	16	7	21	8	..	..	..	..
Uncertain ....	..	..	..	..	..	..	..	..	..	..	41	..	38	..
Totals, month .	20	3	15	6	54	19	16	7	21	8	41	..	38	..

TABLE IIa—continued :—

Tree.	October.		Nov.		Dec.		Totals per tree.		Per cent.
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	
Co	16	..	..	..	20	..	148	..	.....
E3	20	..	24	..	..	..	91	..	.....
F6 .....	..	..	..	..	..	..	46	..	.....
Certain .....	..	..	..	..	..	..	126	43	34.1 per cent.
Uncertain	36	..	24	..	20	..	159	54	Calculated at the same rate.
Totals, month .	36	..	24	..	20	..	285	97	Probable total.

TABLE IIB.—POLLINATIONS AND RESULTING NUTS THEREOF ON ROTUMA COCONUT TREES, NAGASAU.

Tree.	March.		April.		May.		June.		July.		August.		Sept.	
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.
Rotuma, Green	14	4	12	6	..	..	12	6	4	2
Rotuma, Red	14	3	14	4	15	4	13	1	15	5
Certain	28	7	26	10	15	4	25	7	19	7
Uncertain
Totals, month	28	7	26	10	15	4	25	7	19	7

TABLE IIB—continued :—

Tree.	October.		Nov.		Dec.		Totals per tree.		Per cent.
	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	Poll.	Nuts.	
R. green .....	..	..	..	..	..	..	42	..	.....
R. red	12	..	10	..	..	..	93	..	.....
Certain .....	..	..	..	..	..	..	113	35	3.9 per cent.
Uncertain	12	..	10	..	..	..	22	7	Estimated at the same rate.
Totals, month	12	..	10	..	..	..	135	42	Probable total.

SUMMARY.

1. Coconut pollen germinates best in a 25 per cent. saccharose solution containing $4\frac{1}{2}$ per cent. gelatine.
2. Clean pollen of a healthy coconut tree stored in a dessicator containing 35 per cent. sulphuric acid was found viable after 16 days with a germinating power in above-mentioned solution of from 35 to 60 per cent.
3. Uncontrolled pollinating is established by wind as well as by insects, especially by bees and a small fly.
4. Bees being essential for performing pollinations in order to obtain a higher yield of nuts, bee-keeping ought to be encouraged among coconut planters.
5. For controlled pollinating only pollen of a high vitality should be used.
6. Coconuts can be grown in Fiji by means of artificial pollination.
7. Uncontrolled selfing is possible with Malayan Dwarfs, but impossible with Niu Lekas and Rotumas. Controlled selfing is theoretically possible

with any coconut variety as long as the interval between the male and the female phase of the same spathe is shorter than 16 days.

8. The results obtained in Taveuni with cross pollinating between Malayan Dwarfs (female) and Niu Lekas (male) was 27½ per cent., between Niu Lekas (female) and Malayan Dwarfs (male) was 34.1 per cent., between Rotumas (female) and Rotumas (male) was 30.9 per cent.

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DERMATITIS IN CATTLE IN FIJI.

By CHAS. R. TURBET, B.V.Sc., Government Veterinary Officer.

IN previous experiments conducted in July to November, 1925, and duly reported to the Superintendent of Agriculture, I failed to reproduce the condition of Dermatitis in cattle and to determine the cause. In these experiments, however, the eight cattle used had been born and raised in the vicinity of Suva. I have been impressed since then with the fact that the disease occurs chiefly among animals which have been subjected to hardship or change of habitat such as occurs when these are brought to Suva or some other place by boat, or overland. It is assumed that these animals are in a state of partial starvation, lowered vitality and possible slight gastrointestinal disturbance. Also the possibility existed that local animals are tolerant to the toxic principle causing the condition, and that this tolerance was not shared by animals reared in other districts.

In the experiments now conducted I secured eight calves about six months old from Navua and transported them by punt to the Quarantine Station at Suva so that the conditions would resemble as nearly as possible to those under which animals previously had been naturally affected. The calves had a particularly quick trip from Navua and arrived in good condition. In addition to the eight calves from Navua, two calves born at the animal quarantine station were included in the experiments.

I had previously had erected at the quarantine station four adjacent pens about 12 feet square. The grass within these pens was cut to ground level. A minimum of shade was provided, one sheet of iron diagonally across a corner of each pen and a 4 feet square of hessian suspended to throw a square of moving shade.

The calves arrived at 4.30 p.m. on 30th December, and were distributed and fed as follows:—

Calf No.	Pen No.	Feed given.	Colour.	Remarks.
1 2	1	Sensitive plant (<i>Mimosa pudica</i>) <i>ad lib.</i>	Black and white, white muzzle. Do.	
3 4	2	<i>Lantana camara</i> , Para grass in equal parts, chopped, one benzine tin of each twice daily.	Black and white, black muzzle with small white area. White and black, black muzzle with small white area.	Small proportion of rice bran given to improve the flavour.
5 6	3	Leaves and pods of Rain tree (<i>Albizia lebbek</i>) <i>ad lib.</i>	Black and white, black muzzle. Do.	
7 8		Running on grass in the main Quarantine Station paddocks.	Red and white, light-brown muzzle. Do.	Dipped. Not dipped.
9 10	4	Mixed grasses, <i>ad lib.</i>	Brown Jersey colour. White ring around nose. Black and white, black muzzle.	Both dipped as a control against the assertion that dipping caused the disease.

The following observations were made on their subsequent behaviour and condition:—

December 31st, 1927.—No symptoms showing in any calves, but those on *Lantana*, Nos. 3 and 4 not relishing their food.

January 1st, 1928.—No symptoms. All animals eating well except those on *Lantana*. These latter, however, consumed a considerable portion of their rations.

January 2nd.—The two calves, Nos. 3 and 4, on *Lantana*, feeding better.

January 3rd.—No change.

January 4th.—Calf No. 3 on *Lantana* constipated. Calf No. 4 to a lesser degree.

January 5th.—No further change.

January 6th.—No further change.

January 7th.—Calves Nos. 3 and 4 on *Lantana* off their feed, one lying down with head stretched out, slight grinding of the teeth heard from both, both constipated.

January 8th.—Calves Nos. 3 and 4 on *Lantana* obviously ill, not eating, slight swelling of skin of muzzle, particularly of the white patches, yellowish exudation from the skin of muzzle, catarrhal exudate from the nostrils and eyes, slight icterus, flies swarming around the eyes, skin of white areas of back of No. 3 inflamed and hardened by serous exudate, in marked contrast to the black areas of skin which was still soft and supple, frequent small emissions of bile-stained urine.

January 9th.—Condition of the two calves on *Lantana* slightly worse, symptoms of Dermatitis distinct but not as markedly pronounced as in some other naturally occurring cases.

January 10th.—No marked change in condition of the sick animals. All the other animals included in the experiment remain healthy.

January 11th.—In the morning I took Mr. Thomas, retired Meat Inspector, to see the experiment. He had seen a considerable number of cases of Dermatitis. I showed him all the animals in the different pens and asked him whether he thought any were sick. He indicated the two on *Lantana* as being ill. To my question as to what he thought was wrong with them, he immediately replied "Dermatitis." In the afternoon I took Mr. Mune, Manager of Leyland's Limited, Butchers. His replies to my questions were the same as Mr. Thomas'.

January 12th.—I invited Dr. Tothill, Superintendent of Agriculture, and Mr. Ellis, Meat Inspector, who had seen a lot of the disease, to go with me to the quarantine station to see the experiments. On arrival I found that calf No. 3, one of those feeding on *Lantana* had died.

The remaining live calf, No. 4, in the *Lantana* pen was examined, the lesions on the calf were not pronounced. The mucous membrane of the eye were slightly icteric, catarrhal exudate from the nostrils which showed the typical swollen brownish-yellow coloration, the white patch on the black muzzle was swollen and covered with a yellowish-brown exudate, necrosis of the superficial cells was evident. Although this calf was more white than black the only skin lesions were a small cracking of the skin in a transverse direction on top of the withers on a white area. The pigmented skin in the same region adjacent to the lesion not affected. Yellowish serum exuded from these cracks.

Mr. Ellis gave as his opinion that both animals were affected with Dermatitis, thus confirming my own diagnosis.

A post-mortem examination was conducted on the carcase of the dead calf by myself and Mr. Ellis.

AUTOPSY.

The external lesions have already been noted. There was a small necrotic ulcer-like patch on the gums of the upper incisors, the subcutaneous tissues were not as markedly icteric as in some cases of Dermatitis, although the colouration was distinct enough, particularly in patches in the inter-muscular septa and on the course of lymphatics and in joint capsules. The muscles were discoloured. The mucous membrane of the rumen peeled off on taking it in the fingers as though it had been scalded with boiling water. The omasum was apparently normal (an excessive dryness has been noted in most naturally occurring cases). The mucous membrane of the abomasum, particularly towards the pylorus was inflamed slightly and along the course of the small intestine was a more or less diffuse slight inflammation, not very severe in any part. The chief lesions were found as usual associated with the liver and gall-bladder.

The liver was enlarged, friable, slightly mottled and of a dull yellowish-red colour. The colouration was not as pronounced as in other naturally occurring cases which I have examined, some of which could well be described as ochre-yellow.

The gall-bladder was greatly enlarged, holding about 40 ounces of bile (calf six months old). The wall was stretched to extreme thinness and in parts was bile-stained on the outside as though bile were weeping through.

The organs in contact with the gall-bladder were all definitely bile stained. The bile was thick and viscid, there was no definite blockage of the bile duct, although there was a certain amount of catarrh of that passage. The kidneys and spleen were normal. The pancreas was bile stained, probably from its proximity to the gall-bladder. In the abdominal cavity there was a small amount of bile stained serous exudate. The bladder was distended and urine bile stained.

These findings agreed in major detail with other findings at autopsys on animals dead of Dermatitis.

January 13th.—The other calf, No. 4, ill with Dermatitis, no worse. All other animals under experiment still healthy. No. 4 was fed plain grass.

January 15th.—Calf No. 4 was fed plain grass and was slightly better.

January 19th.—Calf No. 4 almost well again. Exfoliation of dried scab from muzzle and anterior nares and withers left healthy tissue beneath. Slight desquamation of epidermal scales from backs of ears—indicate that there has been a slight serous exudate there which I had not discovered previously. That would conform to the usual findings.

I consider that this had completed the first part of the experiment and calf No. 4 was turned out to grass and was not utilised in the next series which I undertook.

All through these experiments the calves, Nos. 1, 2, 5, 6, 7, 8, 9, and 10, remained healthy. The two calves, Nos. 3 and 4 affected were in No. 2 pen between pens Nos. 1 and 3 containing calves Nos. 1, 2, and calves Nos. 5 and 6 respectively. These were fed sensitive plant and rain tree respectively. The calves dipped as a control remained healthy. The calves

running loose in the station paddock, where natural occurring cases had occurred, were not affected.

The amount of *Lantana* growing in the quarantine station was scanty. There were but few seedlings from six inches to a foot in height. On the seaward side of the station, however, between the fence and the sea wall, an area varying in width from three to twenty feet, a considerable amount of *Lantana* was growing. On examination it was found that cattle could easily have reached this *Lantana* by thrusting the head through between the wires of the fence.

CONCLUSIONS.

The condition known as Dermatitis affecting cattle in Fiji is caused neither by the ingestion of the sensitive plant (*Mimosa pudica*) nor the leaves or pods of the rain tree (*Albizia lebbek*), nor by the effects of dipping in Cooper's Cattle Dip 1/150 dilution giving a strength of As_2O_3 of .19 per cent.

Two calves fed on *Lantana camara* contracted Dermatitis whilst eight other calves under practically similar conditions and in close proximity but fed on other fodder remained healthy (*Lantana camara* has been present in all paddocks where Dermatitis has occurred).

From these results I conclude that the ingestion of *Lantana camara* can cause the conditions known as Dermatitis affecting cattle in the Suva and Lower Rewa districts of Fiji.

FURTHER EXPERIMENTS.

In order to put the question beyond doubt it was decided to conduct a further series of experiments to determine:—

- (a) the quantity of *Lantana* required to be ingested to produce the disease known as Dermatitis;
- (b) the variation in susceptibility of a number of animals;
- (c) whether Suva-bred animals had any immunity or tolerance of the disease.

To that end calves Nos. 1, 2, 5, 6, 7, 8, 9, and 10 were utilised and distributed as follows:—

Calf No.	Pen No.	Feed.	Remarks.
1	1	Equal parts of <i>Lantana camara</i> and Guinea grass.	Calf No. 2 showing signs of severe worm infestation.
2	1	Do.	
5	3	Equal parts of <i>Lantana camara</i> and Guinea grass.	.....
6	3	Do.	.....
8	4	Equal parts of <i>Lantana camara</i> and Guinea grass.	.....
9	4	Do.	Calf No. 9, Suva bred animal.
7	At large	Mixed grasses.	Control.
10	Do.	Do.	

On 20th January, this series of experiments was commenced. Calves Nos. 1 and 2, 5 and 6, and 8 and 9 received one feed of grass chopped in the

morning and nothing in the afternoon. Calf No. 4 was turned out and not considered. Calves Nos. 7 and 10 were allowed at liberty in the paddock to graze. No precautions were taken to keep them away from the vicinity of the pens containing the other animals feeding on *Lantana*. In fact they were observed more than once during the experiments to put their heads through the fence and drink water from the troughs within the pens containing the sick animals. This contact, without infection, increased their value as controls.

January 21st.—Calves Nos. 1 and 2, 5 and 6, 8 and 9 were fed *Lantana* and guinea grass in equal proportions, the weight of *Lantana* being 7 lb. This feed was not relished although about half the feed was eaten morning and evening.

January 22nd.—The same feed was given, slightly more being consumed at each feed.

January 23rd.—Calves Nos. 1 and 2 both showing disturbance of health, (calf No. 2 at the commencement showed signs of severe worm infestation, evidenced by unthriftiness, enlarged abdomen, œdema in submaxillary region), not eating, constipation, grinding of teeth, shaking of head, mucoid discharge from nostrils and lacrymal discharge from eyes. Nos. 1 and 2 did not receive *Lantana* on this date and were subsequently given grass alone. Nos. 5 and 6, and 8 and 9 received the usual *Lantana* ration.

January 24th.—Calf No. 1 showed discharge from eyes, muzzle slightly inflamed with brownish-yellow exudate, Dermatitis affecting white parts of skin of back with exudation of yellowish serum matting the hair; animal constipated and restless, body screwed in a peculiar manner behind as though shrinking from pain, which it undoubtedly had at the time.

Calf No. 2, less prominent Dermatitis symptoms, but great depression and debility, constipated.

Calves Nos. 5 and 6 received no *Lantana* and were put on to guinea grass alone. These animals were showing no symptoms.

Calves Nos. 8 and 9 were continued on *Lantana* and were showing no symptoms.

January 25th.—Calf No. 1 showing Typical Dermatitis and the condition progressing.

Calf No. 2 was dead in the pen in the morning.

AUTOPSY.

Carcass emaciated, very slight inflammation of skin of white portion of muzzle. No lesions on skin, subcutaneous œdema marked, icterus, marked œdema of submaxillary region, gelatinous and yellow. Pleural cavity contained pleuritic fluid clear yellow, adhesions between pulmonary and parietal pleura, slight pleurisy of old standing, œdema of base of lungs, pericardium, and mediastinal space. Parasitic pneumonia present (*Dictyocaulus viviparus*). Abdominal cavity contained about two litres yellowish clear fluid, rumen normal, omasum unusually dry content, abomasum slightly hæmorrhagic, intense infestation with *Hæmonchus contortus*, a few petechial hæmorrhages on great omentum; liver slightly smoky in colour; gall-bladder not enlarged but bile viscid and yellow-brown. Spleen normal, œdema about portal fissure. Perirenal tissue œdematous and icteric, no demonstrable fat present. Hilus of kidney œdematous and icteric. The icteric condition was present only in association with œdematous areas.

The findings of this autopsy cannot be said to be absolutely characteristic of the disease known as Dermatitis. Three findings, however, coincide, unusual dryness of the omasal contents, viscid nature and colour of the bile and the tendency to general icterus. Four days after commencing to feed on *Lantana* this animal was dead. If this animal died from *Lantana* poisoning it is the earliest recorded death. Assuming that it did die from that cause I consider that the early onset of the disease and early death was due to the rapid action of the toxin on the debilitated animal, death occurring before the onset of typical symptoms of Dermatitis.

Calves Nos. 5 and 6; 8 and 9 not showing any symptoms. Nos. 8 and 9 were continued on *Lantana*. The control animals Nos. 7 and 10 showing no symptoms

January 26th.—Calf No. 1, disease progressing, emaciation, sunken eye, icterus, unpigmented skin devitalised, hard and yellowish-brown; urine frequently emitted in small quantities golden-brown in colour; constipation, muzzle yellowish-brown, dry smooth scab, becoming necrotic in area where nasal discharge was flowing over it, greyish in colour, small quantities of guinea grass eaten.

Calf No. 5 not eating, clear nasal discharge.

Calf No. 8 shaking the head, clear nasal discharge.

Calf Nos. 6 and 9 not showing any symptoms.

January 27th.—Calf No. 1, Typical Dermatitis, very depressed, not eating or drinking.

Calves Nos. 5 and 6 dull, not eating well.

Calf No. 8, muzzle swollen, slightly inflamed, clear discharge from nostrils, eyelids swollen, ears swollen over area of $1\frac{1}{2}$ inches from the edge all around. Shaking of head, flapping of ears, grinding of teeth.

Calf No. 9, diarrhoea and emaciation, otherwise bright and no signs of Dermatitis.

January 28th.—Nos. 8 and 9 still continued on *Lantana*.

Calf No. 1, skin lesions drying up and hard.

Calf No. 8 more advanced Typical Dermatitis lesions.

Calves Nos. 5 and 6 showing slight symptoms, dullness, not eating. Urine rich yellow-brown colour. Watery discharge from nostrils. On No. 5 one spot on white area, one inch in diameter exuding yellow serum. Eyes slightly icteric.

Calf No. 9 not showing any signs of Dermatitis.

January 29th.—Calves Nos. 1, 5, 6, and 8 all showing Typical Dermatitis in varying degrees.

No. 9 no lesions.

January 30th.—No change.

January 31st.—Calf No. 1 very ill. All others liberated from pens to graze.

I would have been quite satisfied for the experiments to stop at this stage. The condition known as Dermatitis had been produced.

February 1st.—Calves Nos. 1, 5, 6, and 8 typical cases of Dermatitis.

Calf No. 9 not ill.

February 2nd.—Rain had fallen overnight and in the morning. At 2 p.m. the animals were inspected and No. 1 was found in a comatose state, just living. The attendant had thought the animal dead for three hours.

No. 5 was also found dead in the paddock.

Autopsys were held.

Calf No. 1, age 6 months, colour black and white, muzzle white.

AUTOPSY.

Calf No. 1, skin of white areas board-like, devitalised, hardness due to necrosis and drying of exuded serum on surface, loss of hair, yellowish-brown in colour, horns fallen off (early inflammation around base of horns noticed) coronitis. Legs and brisket very œdematous. Pigmented skin supple. Eyes sunken and icteric, gelatinous exudate present. Muzzle necrotic area over brownish-yellow scab. Subcutaneous tissue œdematous and icteric, almost orange yellow. Orange yellow serous exudate in peritoneal cavity. Intestines almost empty, but no marked inflammation. All stomachs fairly normal, no peeling of mucous membrane or marked inflammation. Liver 6 lb, yellowish-brown in colour, gall-bladder not markedly enlarged, about 400 c.c. bile, viscid. Kidney icteric especially in hilus. Lymph glands œdematous and icteric. Bladder distended to utmost with clear rich golden-brown urine. No catarrh of urethra. No congestion of sneiderian m.m. Carcase generally icteric. No body fat.

Calf No. 5, age 6 months, colour black and white, black muzzle, black pigmentation under the white hair. Skin lesions very slight, slight necrosis of skin of muzzle where mucous discharge had drained over muzzle. Rectum contained hard fæcis. Small erosion of gum in area $\frac{1}{4}$ inch square yellowish. Eye sunken and icteric. M.m. of mouth icteric. Inward lesions identical with those of No. 1. This calf did not show as marked symptoms as did No. 1. Liver weighed 6 lb.

February 3rd.—Calf No. 6 was found down in a comatose condition with heart beat barely perceptible, respiration very slow and shallow. Animal was destroyed and an autopsy held.

AUTOPSY.

Colour black and white, black muzzle, black pigmented skin under the white hair, age 8 months. A few small areas of skin about the size of a shilling only were affected with a yellow serous exudate which had dried. Eyes sunken and icteric. Carcase emaciated. A continuation of this autopsy revealed lesions identical with those of No. 5. Liver weighed 6 lb.

Calf No. 8 was showing typical lesions, grazing a little but very dejected, cachectic.

Calf No. 9 showing no signs of Dermatitis, eating well, bowel motions softer than normal and condition poor. The eye bright and muzzle normal, cud chewing indulged in.

February 6th.—Calf No. 8 still alive, feeding a little but very cachectic, anterior nares almost occluded with dried mucous discharge. Areas of white skin devitalised, hard dry yellowish-brown in colour. Eyes sunken, icteric. The edges of the ears necrotic and recurving. Calf No. 9 still showing no signs of Dermatitis.

FEEDING EXPERIMENT WITH GUINEA PIG.

Owing to shortage of Guinea Pigs only one could be secured. This was a healthy, robust male about two years old. On the 27th January, he was

placed in a cage and fed a small quantity of *Lantana* tops. He was not observed to eat any of this, and so was practically starved for that day.

On the 28th he was again fed *Lantana* and was observed to eat a little.

On the 29th he was given a few shoots of grass with the *Lantana*, but was not observed to eat any *Lantana* but ate the grass. He appeared tucked up and soiled.

On the 30th, Guinea Pig ate a little grass but appeared dejected and had unclean coat, staring, eye watery and conjunctiva possibly faintest yellow.

February 1st.—The Guinea Pig found dead in its cage.

AUTOPSY.

Minute yellow specks on liver substance. Liver slightly enlarged, iteum hæmorrhagic, also large intestine. Inflammation of large intestine, constipation. The inflammation of the large intestine was the most prominent feature.

Death was due evidently to a toxæmia, whether a toxin from the *Lantana* or an autointoxication, one cannot say.

This latter experiment is in conclusive, in as much as that, although a previously healthy guinea pig died after eating *Lantana*, there was no control and one is not sure that the *Lantana* caused the death, although the evidence points that way.

CONCLUSION.

a. Probably one feed of *Lantana* of about 7 lb is sufficient to produce the disease, known as Dermatitis, in susceptible animals.

b. Seven calves out of seven brought from Navua and fed *Lantana* contracted Dermatitis, hence it is safe to assume that all cattle not accustomed to the presence of *Lantana* amongst their grazing are susceptible, provided they eat it. The fact that only a percentage of animals brought to Suva contract Dermatitis naturally can be explained by assuming that only a per centage eat the plant although all are in contact with it.

c. The following facts indicate that Suva-bred animals are tolerant to the toxin of *Lantana*:—

1. Suva-bred animals (except small calves just commencing to graze) do not contract Dermatitis.
2. Eight Suva-bred animals experimentally fed *Lantana* in 1925 did not contract Dermatitis.
3. Calf No. 9, a Suva-bred animal, in the present series of experiments when continuously fed *Lantana*, did not contract Dermatitis whilst five Navua-bred calves receiving from one feed to many feeds in the same experiments, contracted the disease.

d. The condition known as Dermatitis affecting cattle in Fiji is caused by the ingestion of *Lantana camara* and in future the disease should be known as *Lantana* poisoning.

POLYARTHRITIS IN PIGS.

By W. G. BENNETT, B.V.Sc., Government Veterinary Officer.

An outbreak of Polyarthritis in pigs, which is also known as Joint Ill, was investigated by Mr. T. T. McGrath, in February last at Ba.

This is a disease of young stock, not confined to pigs only but occurring also in calves, foals, and lambs. It is due to an infection by way of the umbilicus, with a widely distributed organism of the *Pasteurella* group, which exists in the soil in a similar manner to the tetanus bacillus, and tends to remain localised on the land where the disease occurs. Outbreaks of the disease occur in waves.

As the position and character of the umbilicus render it particularly easily soiled, special attention in the way of antiseptic dressings and cleanliness to this region are essential in young animals.

In the case under review, the disease manifested itself only among young pigs up to three weeks old, with typical symptoms, viz.: extreme weakness and emaciation, inability and lack of desire to take nourishment from the mother and general unthrifty appearance. Later the joints became hot and painfully swollen. On opening such swellings a caseous pus was found which, on microscopical examination revealed the presence of the *Pasteurella* organism. Abscesses also occurred in the umbilical region.

The outbreak at the Rarawai piggeries was no doubt due to a purely local infection of the soil, since it is of very rare occurrence in Fiji, and there is no probability of its becoming enzootic in this country.

CONTROL MEASURES.

Treatment of this condition, as a rule, yields poor results, and preventive measures are much to be preferred. The first essential to prevention is cleanliness. When an animal is known to be due to litter it should be placed in a clean, dry stall with plenty of fresh air. New straw should be put down on the floor and care taken to see that drainage from the spot is good. The genital organs of the female should be dressed with an antiseptic solution, *e.g.*, 1 in 1,000 corrosive sublimate or 3 per cent. carbolic acid. The umbilical cord of the young should also be dressed with this solution and tied off with disinfected string as soon as the pulsations stop. Dressings should be continued until the umbilicus is completely dried up. The parturition box itself should be disinfected after each litter.

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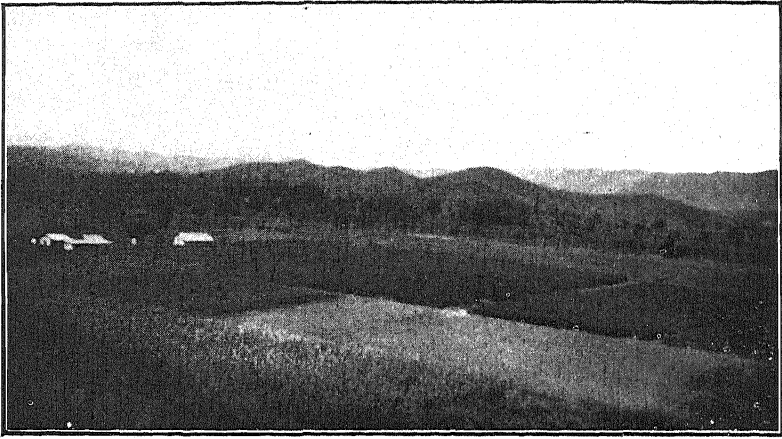
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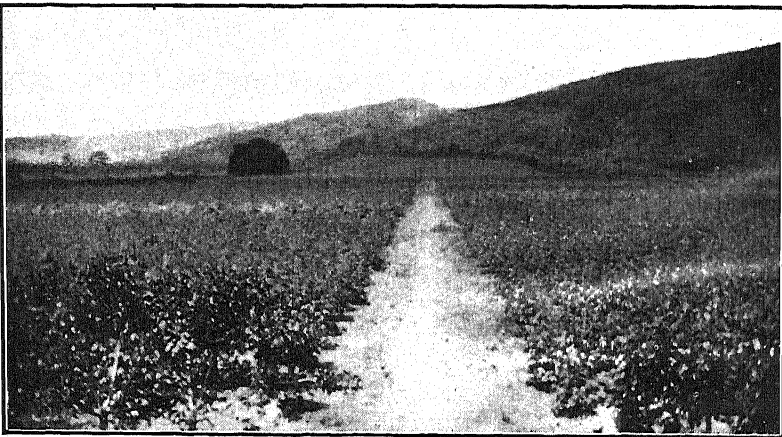
Sea Island and Kidney types have
done best at the Station.



K 3 type of Single Seeded Kidney
Cotton from New Guinea.



A general view of the Cotton Experimental Station
in the Sigatoka Valley.



Experiments in ratooning Kidney Cottons are
being conducted in this field.

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. I.]

FOURTH QUARTER, 1928.

[No. 3.

THE POSSIBILITIES OF A NEW VARIETY OF COTTON FOR FIJI.

By ROSS R. ANSON, Cotton Specialist.

DURING the past few years the uncertainty of the market for Sea Island cotton has made it necessary to carry out experiments, with a view to seeing whether it will be possible to substitute the growing of it by some other variety which will be more saleable, and at the same time give the grower as good a return per acre.

VARIETAL EXPERIMENTS.

Several varieties have been tried out at the Cotton Experiment Station including Kidney, Meade, Acala, Tanguis, Pima, Sakellaridis, and a few useful types of cotton have been crossed with Sea Island. The variety which has shown the greatest promise up to the present is a Kidney Hybrid. It originated from a few seeds from five of the most promising of twenty-eight single plant selections, made by Mr. G. Evans from Kidney Hybrid cottons found growing at Kayapet, Markham Valley, New Guinea; of the original twenty-eight selections eleven possessed conglomerate seeds, but the remaining seventeen had seeds which did not adhere together as in ordinary Kidney cotton. Five of these which appeared to be the best, were sent out to Fiji by the Empire Cotton Growing Corporation for trial.

SELECTION WORK.

Last season we were unable to do much selection work, as it was necessary to study the behaviour of each hybrid plant. All the free seeded ones were grouped together, and careful observations were made. Points such as pest resistance, vigour, productivity, size of bolls, length and uniformity of staple, flower colourings, &c., were noted. Four desirable types were selfed and planted on an isolated plot this season.

The type of plant which we are attempting to produce is a robust one with an open habit of growth and large full opening bolls, possessing strong lint of uniform staple length, and good drag. The plant should grow from a single stem or trunk. It should have as few vegetative branches as possible and none within twelve inches of the ground, so that it may be treated with tree tanglefoot, and thus rendered as immune as possible from the second generation of cotton stainers.

COMPARISON WITH SEA ISLAND.

It is a well known fact that owing to its length, strength, and fineness of staple, Sea Island has always commanded a higher price than other cottons, but the size and character of the bolls make picking difficult, and a picker

can rarely maintain an average of more than 30 lb of seed cotton per day. A cotton that will compare favourably with Sea Island from a grower's point of view, must therefore be a type which possesses a larger boll, a higher percentage of lint, a higher percentage of first-grade cotton to the acre, which is a better yielder and which at the same time produces lint of such quality that the price will be as close as possible to that of Sea Island.

During the past four seasons the average percentage of Sea Island A and B grades has been high (69.41 per cent.), and it will not be an easy matter to find a cotton that will beat this. The grade and class is governed to a great extent by the weather conditions at the time of maturity, and the drier the weather at the picking time the higher the percentage of good quality cotton. According to the rainfall statistics taken over a period of twenty years in the dry zones of Vitilevu and Vanualevu Islands, the driest weather was experienced during the months of June, July, August, and September. The Sea Island crop when planted in mid November usually reaches maturity in April and picking is continued until the end of July. The Kidney Hybrid planted at the same time does not reach maturity until June and picking continues until the end of September. This just fits in with the driest months and it is hoped that it will therefore be possible to obtain a higher percentage of first grade cotton than is the case with Sea Island. During the present season this seems to be precisely the case and the Kidney Hybrid has so far shown most of the other characteristics which are necessary to make it compare favourably with Sea Island, that is from a grower's point of view, but as yet the variety has not been properly fixed to type and a few individual plants show signs of reverting to one or other of the parent plants and it will be necessary to continue with plant selection work until the type has become commercially pure.

FIXING OF TYPE.

During the first season of issue to a community of growers, it will only be possible to make a general mass selection; it would also be advisable to combine with this method the practice of examining the seed, rejecting all small light gin cracked seed, together with any that shows signs of irregularity of type. For the ultimate fixing to a commercially pure type, the method adopted by most cotton breeders is that of the "Progeny Row System," which is one based on the separate raising of progeny of "selfed" individually selected plants.

To begin with several plants are selected as the best to be found, and the seed from each of these is saved separately. The reason for having more than one plant to start with is that the degree to which the characters of the parent are transmitted are found to vary with different plants. The following year each of these lots of seed is used to establish a row (say of 100 plants). The rows should be adjacent to each other and should either occupy an isolated position or be placed amongst the same variety of cotton of good type, these precautions being taken to prevent as far as possible, the crossing with pollen from inferior plants. Any plants of noticeable inferiority are pulled up as soon as detected. When the plants come into bearing the rows are compared with each other, and the rows which possess the required characters with the greatest regularity are selected. In these again a number of best plants are marked and the seed from each individual saved separately for next year's rows. The seed from the remainder of the plants in each selected row is saved and used for planting separate plots, while that from the non-selected rows should also be kept for planting, since it may be expected to be above the average.

The following year there will be—

1. a new set of rows from the last selected plants;
2. as many seed plots as there were selected rows in the previous year;
3. a certain amount of cotton planted from seed from non-selected rows.

For reasons connected with crossing already indicated the seed plots should be planted around the rows. The selection of rows and individual plants and the planting of seed plots, are repeated in this, and each succeeding year. From the seed plots sufficient seed will be obtained each year to plant a large area. If it is not sufficient for an isolated community of growers, the process may be carried on another step, using the areas upon which the seed cotton is grown, as a seed plot for the following year.

CONCLUSION.

The plant which shows promise of being the best suited to conditions in Fiji, is K 11, but it is not expected to supply a sufficient quantity of pure seed for distribution to an isolated community during the coming season, and in order to test the variety under commercial conditions it will most probably be necessary to distribute seed from K 8, which lacks the lint qualities of K 11, but makes up for this in other respects. It will be possible to distribute seed from K 11 to a separate community in one year's time, and if it proves to be a better cotton, to replace K 8 by it in the following year. In case the demand for Sea Island cotton should increase at some future date, and it should prove to be more remunerative to the growers than the Kidney Hybrid types, it would be wise to keep a stock of pure seed continually on hand, and in order to do this it would be necessary to confine a small island such as Vatulele to the growing of it exclusively.

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, SIGATOKA, FOR THE SEASON 1927-28.

By ROSS R. ANSON, Cotton Specialist.

DURING the past season the experimental work has been conducted on similar lines to those described in my report on the operations of the previous season. In order to provide adequate isolation for the increase plots of the single plant selections, and to allow for crop rotation, it was found necessary to increase the area of the Station and an additional 134 acres has therefore been acquired. This area comprises 50 acres of flat land which, although at present heavily covered with guava and other pests, consists of light friable river silt of great depth, and fair drainage. It is a first-class cotton soil. The remaining 84 acres consists of hill slopes, most of which are not suitable for cultivation purposes, and will be used for paddocking the farm stock. The total area of the Station has now been brought up to 166 acres, of which 80 are suitable for cultivation. This should greatly facilitate the economic working of the Station.

Season.—Continuous rains at the commencement of the season hindered planting operations and many growers had their crops completely washed out, while others were unable to secure a good stand owing partly to faulty seed beds, and partly to the continuous rains and relatively high humidity

in the atmosphere which caused a large percentage of the seed to rot, and poor germination resulted.

At the Station we were more fortunate, thanks to drains and a tractor plough, which enabled us to prepare and plant up fairly large areas in a short space of time, and to take full advantage of favourable weather conditions. In this way we managed to obtain an excellent stand throughout before the heavy rains which set in in February and lasted until May, causing all varieties to put on an abundance of wood and to grow lank and sappy. Some of the Kidney Hybrids and Tanguis cottons grew ten feet high. It was decided to have these topped in order to check the growth, allow the sun to penetrate and to facilitate picking. A sharp cane knife was used for this purpose and plants were pruned to a height of five feet. They were cut by an upward motion of the knife, care being taken to strike the branches just above a node in order to avoid mutilating them as much as possible. Although this somewhat drastic treatment checked the growth and caused plants to be considerably later in reaching maturity, it had the desired effect, and turned a crop which would otherwise have been an eminent failure into a moderately good yielder.

The rains ceased suddenly at the end of May, and thus the later varieties reached maturity in favourable weather, which lasted for four months and added considerably to the ease of picking. A few light showers were experienced, but they were not sufficient to cause any injury to the seed cotton.

Kidney Hybrids.—All the cotton growers who are situated in the Sigatoka River valley will be issued with seed from New Guinea Kidney cottons during the season 1928-29. Seed from the increase plots of K11 will be kept in the vicinity of the Experimental Station. K8 will be given out to a community at the head of the river, K3 type to a community situated centrally between two ranges, while K1 is to be given to those who are situated between the Station and the mouth of the river. Sea Island cotton is to be neither grown nor ginned in the Sigatoka district, and an Inspector who has recently been appointed for the purpose will insure that all the Sea Island cotton of the district has been uprooted and burnt before the new variety is planted.

Work on selections has of necessity been somewhat rushed, and seed is being distributed from increase plots a little prematurely. This has been brought about by the small demand for Sea Island cotton in the Home markets, and the urgent necessity to increase the output in order to bring down our overhead costs on the crop, and to hold the interest of native growers.

During September of last year, lint samples from four plants were sent to England for spinning tests and the results obtained were sufficiently encouraging to warrant a continuance of the selection work. The lint from all samples averaged $1\frac{3}{16}$ inches in length, and was valued at 14½d. per lb (by the courtesy of Messrs. Wolstenholm & Holland).

Second year selections.—The four single plants, namely, K3-1, K3-2, K8-1 and K8-2, were planted in progeny rows and isolated from other cottons. Owing to the continuous rains and an indifferent seed bed, these plants made only moderately good germination. Careful roguing was carried out on all selections before they had reached the flowering stage. An analysis of these cotton samples was made and the ginning percentages

were taken from 100 gramme lots in each case. The result of these tests is given below:—

No.	Weight of 100 seeds.	Lint index.	Ginning per cent.	No. of bolls per lb	Mean lint length.	No. of plants.	Yield per plant.	Yield per acre.
	gms.				mm.		lb	lb
3-1	12.74	7.02	37	110.03	29	90	.566	821
3-2	14.07	7.47	36	82.3	31	76	1.236	1,794
8-1	14.23	7.96	33.97	83.9	28.5	117	.538	781
8-2	12.93	7.02	34.5	84.6	28.9	88	.795	1,154

Picking has not been completed on any of the above selections and it is estimated that the yields of all will be increased by at least 25 per cent.

K3-2 and K8-2 have kept remarkably true to type and are 100 per cent. free-seeded in both cases, while K3-1 and K8-1 have shown a slight deviation from their parents, both being inclined to produce conglomerate seeds. These two will be given out with the bulk seed during the coming season, and the former two will be sown on increase plots occupying an isolated position at the Experimental Station. They have supplied sufficient seed for ten and five-acre plots respectively.

Picking tests.—Picking tests made on progeny row selections at Koromumu resulted in the best picker reaching a total weight of 80 lb of seed cotton in a ten-hour day, but at the Station where the crop was somewhat lighter the highest tally per day was 60 lb, as against 27 lb on a moderately good crop of Sea Island.

Sea Island.—The seed from six plants selected last year was planted out in progeny rows on an isolated plot at Lawaqa, and the seed obtained from the two best rows (S17 and S25) was planted around them on increase plots. Unfortunately, the portion of the field upon which the selected plants were sown was slightly lower than the remainder and consequently during the five months of heavy and continuous rains the plants suffered badly from wet feet, and their growth was stunted to such an extent that it was decided to discontinue with the selection work and to issue seed for propagation next year from the bulk lot only. This will be given out to a few good cultivators who occupy isolated positions in the Lautoka district, and should it be decided to continue with the growing of the Sea Island variety in this Colony, the above mentioned seed would form the nucleus for further selection work in the coming season.

Varietal tests.—The tests were conducted on similar lines to those indicated in my last report, the only difference being that the area set aside for the purpose was divided into quarter-acre instead of half-acre plots in order to make room for a few more varieties. Eight plots of five of the main varieties, each measuring one-fortieth acre, were arranged on the chess-board system as a check against soil variation.

Sea Island.—Up to the present date Sea Island has given the highest yield. It reached maturity earlier than the Kidney types and all pickings have now been completed on it. During May 25 per cent. of the crop was damaged by rain.

Kidney Hybrids (from New Guinea).—These hybrids and the local Kidney reached maturity at a much later date than any of the other varieties. Pickings have not yet been completed from any of the Kidney types and it is estimated that the yield from all the plots will be increased by at least

25 per cent. The bolls opened well and the lint which was of moderately good quality was easily picked.

Sakel.—Both Egyptian and Sudan strains were badly attacked by *Bacterium malvacearum*, which, together with the late rains, caused them to shed very badly. The variety is not considered to be suited to the local climatic conditions.

Tanguis.—This variety was also attacked by *Bacterium malvacearum*. It put on a large crop which it shed immediately after flowering. All plants put on an excess of wood and had to be cut back, and on this account they were later in reaching maturity than would otherwise have been the case. There is another picking to be gathered from the top crop which should increase the yield of all the plots by at least 30 per cent.

Meade.—Meade was attacked by *Earias fabia* early in the season. It matured during the wet months and bolls failed to open well. It is considered unsuitable for this climate and further experiment with it will be discontinued.

RESULTS OBTAINED FROM VARIETAL TESTS.

Plot No.	Area.	Variety.	Date sown.	First picking date.	No. of cultivations.	Yield per acre.
1	½	Sdn. Sakel	7/11/27	25/4/28	5	lb 298
2	"	Sea Island	7/11/27	5/4/28	5	790
3	"	Tanguis	7/11/27	24/5/28	6	412
4	"	Egpt. Sakel	8/11/27	1/5/28	5	274
*5	"	K8	10/11/27	24/5/28	6	1,012
6	"	K3	8/11/27	4/6/28	4	790
7	"	Meade	8/11/27	16/4/28	4	518
8	"	K1	11/11/27	4/7/28	5	728
9	"	Tanguis	11/11/27	5/5/28	5	346
10	"	K8	11/11/27	3/5/28	4	772
11	"	Meade	11/11/27	27/4/28	5	504
12	"	Sdn. Sakel	10/11/27	20/4/28	4	270
†13	"	Kidney Ratoon ..	20/11/26	6/7/28	5	710
‡14	"	Kidney Ratoon ..	20/11/27	13/7/28	4	1,000
15	"	K3	10/11/27	20/4/28	5	796
16	"	Tanguis	9/11/27	5/5/28	5	670
17	"	K1	9/11/27	12/7/28	4	696
18	"	Sea Island	9/11/27	5/4/28	4	1,151
19	"	Egpt. Sakel	9/11/27	12/4/28	4	396
20	"	Sea Island	9/11/27	5/4/28	4	1,228

* All plants in this plot were topped during the second week in April. There is another heavy picking to be reaped.

† This plot was ratooned to ground level and has another light picking to come off it.

‡ Pruned to 3 ft. 6 in. of ground level and a light picking yet to come off.

CHESSBOARD PLOTS 21 AND 22—AVERAGES FROM EIGHT 1/40-ACRE PLOTS.

Variety.	Area.	Date planted.	Date of first picking.	Cultivations.	Yield per acre.
Sudn. Sakel ..	2	6/12/27	3/5/28	5	lb 245
Sea Island ...	"	6/12/27	5/5/28	5	812
Egpt. Sakel ...	"	6/12/27	5/5/28	5	247
K3	"	6/12/27	5/7/28	5	865
Tanguis	"	6/12/27	6/7/28	5	474

RESULTS OF WEEKLY FLOWER COUNTS MADE ON TWO AVERAGE PLANTS OF ALL VARIETIES.

Plot.	Variety.	Plant.	Weeks.	Flower shedding due to tip worm.	Flower shed from other causes.
1	Sudu. Sakel	1	30	Per cent. ·08	Per cent. 28·0
		2	30	1·20	42·4
2	Sea Island ..	1	30	..	16·3
		2	30	·05	15·0
3	Tanguis	1	24	..	47·5
		2	30	..	70·0
4	Egpt. Sakel	1	30	·19	36·2
		2	30	·27	38·8
5	K8	1	10	..	5·2
6	K3	1	30	..	21·6
		2	30	..	20·8
7	Meade	1	32	2·	22·3
		2	32	1·4	23·6
8	K1	1	30	·23	23·
		2	28	..	20·1
13	Local Kidney ...	1	14	·22	12·
		2	14	..	8·2
18	Sea Island	1	32	·11	23·1
		2	32	..	17·5

The above results are fairly significant. Shedding caused by Pink Boll Worm was slight. It attacked the local Kidney variety more than it did other varieties.

Time of planting and spacing tests.—The above experiment was carried out on similar lines to those described in my previous report. Three quarter-acre plots, one of each being planted during the middle of November, December and January, were planted with rows six feet apart, and an additional three were planted on the same dates with rows five feet apart. Plants were thinned out to the following spacings:—A, 2 ft. 3 in.; B, 3 ft. 6 in.; C, 4 ft. 6 in.; and D, unthinned. The results obtained are not considered to be significant. The unthinned rows gave the best yield, but had the whole plot been planted with unthinned rows it is thought that a large percentage of boll rot would have been brought about, which would probably have reduced the yield by more than half, as it was, the unthinned rows had spaced ones on either side of them which allowed the sun to penetrate, and the percentage of boll rot on them was not particularly heavy.

Row.	Spacing.	Date planted.	Number of plants.	Yield per acre.	Means.
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PLOT No. 23.

				lb	lb
1	5 ft. by 3 ft. 6 in. .	16/1/28	45	143	123.5
2	Unthinned	"	660	260	214.5
3	5 ft. by 2 ft. 3 in. .	"	65	169	130
4	5 ft. by 4 ft. 6 in. .	"	35	78	68.2
5	Unthinned	"	880	169	..
6	5 ft. by 4 ft. 6 in. .	"	36	78	..
7	5 ft. by 2 ft. 3 in. .	"	66	143	..
8	Unthinned	"	1,210	273	..
9	5 ft. by 4 ft. 6 in. .	"	39	65	..
10	5 ft. by 2 ft. 3 in. .	"	69	78	..
11	Unthinned	"	660	156	..
12	5 ft. by 3 ft. 6 in. .	"	39	52	..
13	5 ft. by 3 ft. 6 in. .	"	48	104	..

PLOT No. 24.

1	5 ft. by 3 ft. 6 in. .	16/12/27	46	143	156
2	Unthinned	"	1,265	260	364
3	5 ft. by 2 ft. 3 in. .	"	64	208	294.6
4	5 ft. by 4 ft. 6 in. .	"	35	143	198.25
5	Unthinned	"	1,410	481	..
6	5 ft. by 4 ft. 6 in. .	"	36	221	..
7	5 ft. by 2 ft. 3 in. .	"	65	247	..
8	Unthinned	"	1,100	481	..
9	5 ft. by 4 ft. 6 in. .	"	39	208	..
10	5 ft. by 2 ft. 3 in. .	"	68	429	..
11	Unthinned	"	766	234	..
12	5 ft. by 4 ft. 6 in. .	"	38	221	..
13	5 ft. by 3 ft. 6 in. .	"	48	169	..

PLOT No. 25.

1	5 ft. by 3 ft. 6 in. .	16/11/26	49	572	533
2	Unthinned	"	654	7677	1,014
3	5 ft. by 2 ft. 3 in. .	"	74	702	728
4	5 ft. by 4 ft. 6 in. .	"	40	468	663
5	Unthinned	"	604	1,027	..
6	5 ft. by 4 ft. 6 in. .	"	39	481	..
7	5 ft. by 2 ft. 3 in. .	"	68	676	..
8	Unthinned	"	498	1,339	..
9	5 ft. by 4 ft. 6 in. .	"	39	910	..
10	5 ft. by 2 ft. 3 in. .	"	68	606	..
11	Unthinned	"	544	923	..
12	5 ft. by 4 ft. 6 in. .	"	40	793	..
13	5 ft. by 3 ft. 6 in. .	"	45	494	..

PLOT No. 26.

1	6 ft. by 3 ft. 6 in. .	16/1/28	44	231	231
2	Unthinned	"	1,112	297	418
3	6 ft. by 2 ft. 3 in. .	"	64	253	249.3
4	6 ft. by 4 ft. 6 in. .	"	35	187	183.3
5	Unthinned	"	436	495	..
6	6 ft. by 4 ft. 6 in. .	"	38	198	..
7	6 ft. by 2 ft. 3 in. .	"	55	253	..
8	Unthinned	"	802	462	..
9	6 ft. by 4 ft. 6 in. .	"	37	165	..
10	6 ft. by 2 ft. 3 in. .	"	60	242	..
11	6 ft. by 3 ft. 6 in. .	"	45	231	..

Row.	Spacing.	Date planted.	Number of plants.	Yield per acre.	Means.
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PLOT No. 27.

1	6 ft. by 3 ft. 6 in. .	16/12/27	41	154	253
2	Unthinned	"	719	627	715
3	6 ft. by 2 ft. 3 in. .	"	44	198	370
4	6 ft. by 4 ft. 6 in. .	"	35	176	282
5	Unthinned	"	765	649	..
6	6 ft. by 4 ft. 6 in. .	"	38	363	..
7	6 ft. by 2 ft. 3 in. .	"	68	363	..
8	Unthinned	"	800	869	..
9	6 ft. by 4 ft. 6 in. .	"	41	308	..
10	6 ft. by 2 ft. 3 in. .	"	69	550	..
11	6 ft. by 3 ft. 6 in. .	"	44	352	..

PLOT No. 28.

1	6 ft. by 3 ft. 6 in. .	16/11/27	54	847	896.5
2	Unthinned	"	865	1,628	1,672
3	6 ft. by 2 ft. 3 in. .	"	71	1,144	1,239.3
4	6 ft. by 4 ft. 6 in. .	"	38	891	924
5	Unthinned	"	788	1,595	..
6	6 ft. by 4 ft. 6 in. .	"	39	913	..
7	6 ft. by 2 ft. 3 in. .	"	73	1,276	..
8	Unthinned	"	632	1,793	..
9	6 ft. by 4 ft. 6 in. .	"	44	968	..
10	6 ft. by 2 ft. 3 in. .	"	67	1,298	..
11	6 ft. by 3 ft. 6 in. .	"	47	946	..

Cotton crosses.—Various crosses made during last season at the Station, together with some kindly sent out for trial by Dr. Bancroft of Queensland, were planted out in single lines on a quarter-acre plot set aside for the purpose. All of the Hybrids sent over from Queensland were a complete failure. Those which were not killed off by "black arm" were severely infected with Jassid and produced practically no crop. A brief description of the other crosses is given hereunder.

Acala X Sea Island.—In habit of growth it was somewhat similar to that of Sea Island. The leaves were mostly smooth, about one plant in five possessed Acala characters with slightly hirsute leaves. The flowers resembled those of Sea Island, but the corolla was a paler yellow and the guide marks at the base were much less vivid. The seeds had a heavy greenish fuzz. Bolls were large and about 25 per cent. five-locked. The lint which was fine and silky averaged 38 mm. in length.

Meade X Acala.—These hybrids resembled Acala in habit of growth. The leaves were broad, dull green in colour and very hirsute. The flower a pale yellow with no basal colouration or guide marks opened fully. Seeds were covered with a short white fuzz which gave them a grayish appearance. The fuzz was less dense than that of Acala and the cotton should be a fairly easy ginner. Bolls were very large and about 27 per cent. five-locked. Lint averaged about 35 mm long and was of good quality and free from nep.

Sea Island X Acala.—The plant resembled Sea Island, but leaves were much broader and of a dull green colour and non-hirsute. Flowers were pale yellow and showed very slight brownish markings at the base of the petals which did not vary. Bolls were three, four and five-locked. The

seeds possessed a bright green fuzz and the lint was creamish brown in colour, silky in texture and the staple measured 30 mm.

Sea Island X Meade.—These plants showed slight Jassid resistant properties, and resembled Sea Island in habit of growth. Leaves were smooth, very broad and a dark green. Plants were uniform. Flowers pale yellow with slight basal markings. The bolls were three, four and five-locked (mostly four-locked). The seed had a large white tuft at the apex and was of a chocolate colour. It was slightly larger though very similar to Meade. The lint very silky sparce, but difficult to distinguish from Sea Island and measured 52 mm long.

PLOT No. 29.

Variety.	Weight of 100 seeds.	Lint index.	Ginning.	Mean staple length.	No. of plants.	Yield per line.	Calculated yield per acre.
			per cent.	mm.		lb	lb
Sea Island							
X Meade	13.03	3.47	22.5	52	44	51	2,103.5
Acala X	10.95	7.83	29.5	38	9	10	2,016.4
Meade X	11.31	7.44	32.5	35	93	51	994.62
Caravonica from Noumea	16.57	7.7	32.7	28.6	3	..	1,815

Time of flowering and bolling averages.—Four plants from each variety were labelled and daily observations were made. Five squares on each plant were marked by coloured ribbons, and the results given below are the averages taken from twenty marked squares in each variety:—

Variety.	Planting to squaring.	Squaring to flowering.	Flowering to maturity.	Remarks.
	Days.	Days.	Days.	
Sdn. Sakel	37	21	52	.....
Sea Island	37	21	63	.....
Tanguis	37	28	82	Topped during April.
Egp. Sakel	36	21	52	.....
K8	SI 42	25	59	There were two types—Sea Island and
	K 104	52	80	Kidney type.
K3	102	55	75	.....
Meade	36	17	49	.....
K1	101	60	83	.....
Kidney Ratoon ..	128	31	85	128 days from date of ratooning.

Pests and diseases.—*Jassid* was most prevalent during the months of March, April and May, but disappeared with the advent of dry weather and most of the varieties which had suffered from it made a rapid recovery. Tanguis was resistant.

Pink Boll Worm (Platyedra gossypiella).—During the season under review very little damage was caused by this pest. It was most probably kept in check by parasites. It was more prevalent on the local Kidney than on any of the other varieties, but only about 3 per cent. of the seed cotton was injured by it.

Cotton stainers (Dysdercus insularis).—Until the latter part of the season stainers were kept in check by hand collection. Every three or four days small boys were sent along the rows with kerosene tins containing half a gallon in equal part of kerosene and water, and into these tins the stainers were shaken from the branches.

Experiments were tried out with different types of Tanglefoot on Kidney Hybrid cotton (K8 type, which is almost a tree cotton). That which was imported from the United States of America was found to be the best, in that it prevented all stainers that were in the nymph stage and unable to fly from reaching the cotton and only quite a small number of adults were found on the bolls, but it is too expensive to be advocated on a commercial scale.

Trials were made with resin, local gums, linseed oil, &c. Some of these mixtures acted quite well for the first week or so, but soon lost their tenacity.

Harlequin bug (Tectacoris lineola).—These pests were also kept in check by hand collection and did not at any time reach major proportions.

Fruit fly (Dacus passiflorae).—Despite a careful search throughout the season, the fruit fly could not be found on any of the varieties.

Tip worm (Earias fabia).—The incidence of the pest was light and affected Meade more than it did other varieties.

Black arm (Bacterium malvacearum).—This disease first made its appearance on Tanguis and caused a number of the plants to die back. It was later found on both strains of Sakel. Other varieties were not affected by it a great deal, but traces of it were found on a few plants from all varieties.

Future prospects.—Although the two past seasons have been very discouraging, and growers had at one time lost all interest in cotton growing, the prospects for the future development of the industry appear to be much brighter, and native growers of this district are quite keen to obtain seed of the new Kidney variety. It is anticipated that between 700 and 800 acres will be planted with it during the coming season, 1928-29. The estimated acreage for all other districts is 2,000 acres which will be planted with Sea Island.

Programme for 1928-29.—In the forthcoming season most of the time will be devoted to plant selection and breeding work with new Kidney Hybrids, and many of the varieties grown in the varietal tests last season will be done away with. Spacing tests will be discontinued with Sea Island cotton. Experiments will be carried out with various methods of ratooning Kidney types, together with spacing and topping experiments.

Conclusion.—In conclusion I should like to express my gratitude to the Superintendent of Agriculture and the Government Cotton Inspector for much appreciated and helpful co-operation by them, which greatly assisted operations on the Station. Also to my two field assistants, Messrs. H. V. Petley and C. M. Dass, who have both carried out their work very satisfactorily.

NOTES ON PASTURE PLANTS IN FIJI.

By J. D. TOTHILL, D.Sc., Superintendent of Agriculture.

DURING the last two years the Government Chemist has been engaged from time to time upon an analysis of pasture plants known to do well in this Colony. The work has gone far enough to enable conclusions to be drawn, but as the publication of a bare table may not be very helpful I will endeavour to explain the way in which this table of analyses can be turned to practical account. The table will be found at the end of this article, and for the sake of comparisons I have added an analysis of two of the finest forage plants known outside the tropics, namely, lucerne and meadow fescue, the figures for these being taken from the admirable text book on feeds and feeding by Henry and Morrison.

To take an example, the table shows that in 100 pounds by weight of fresh green *Paspalum dilatatum* there were 76.81 pounds of water, 2.51 pounds of protein, .36 pounds of fat, 6.9 pounds of crude fibre, 11.02 pounds of carbohydrates, 2.2 pounds of ash, .1 lb of lime and .13 pounds of phosphoric acid.

The lime and phosphoric acid are necessary for the production of bone, but need not concern us in this article. The ash, which is that part of the grass that cannot be burned after a long exposure to a hot flame, contains other essential mineral ingredients without which animals cannot live for long but which need not concern us at this time. Crude fibre is incapable of digestion and though useful as roughage has no value as a food ingredient. Most forage plants consist chiefly of water which helps to make them succulent and palatable but which is not, strictly speaking, an essential food ingredient. The remaining items of protein, fat and carbohydrates are the important ones from a dairyman's point of view.

Protein is, without doubt, the most important of these three classes of foods. The dry material in animal bodies—apart from minerals and fats—consists almost wholly of proteids and they are an essential constituent of all living cells whether plant or animal. An animal could exist for a protracted period without carbohydrates or fats, but proteids are essential to life and growth. They contain not only carbon and hydrogen and oxygen but sulphur and nitrogen, and some of them contain phosphorus. They have a very complex chemical structure and, while they can be modified, they cannot be manufactured by the processes of animal metabolism. In eggs we find the vegetable proteids of the fowl's diet modified to albumen in the white and other proteids in the yolk, while in milk the vegetable proteids have been modified and returned, principally in the form of casein—the part of milk which produces the curd.

Fat is a term used to include all oily substances in the forage plant. While not as essential to life as the proteid elements of food, they share with carbohydrates the function of supplying heat and energy when, after absorption, their carbon and hydrogen element are slowly oxidised in the animal's body. In the vegetable kingdom fats occur chiefly in seeds. Chemically they are glycerol salts of fatty acids. They are soluble in ether and may be changed into soaps by treatment with alkalis. They are easily assimilated and may be stored in the form of fatty tissue (chiefly as glycerol stearate in cows) or secreted as in the butter fat of milk (glycerol butyrate).

Carbohydrates are the most abundantly produced food in all plants, including these forage grasses and legumes. They are composed of carbon, hydrogen and oxygen as are fats and they furnish heat and energy as fats do, but the elements are combined in a different way and in different pro-

portions and are subject to different digestive processes when eaten by animals. This class of food is manufactured in the leaves by the chlorophyll or green colouring matter from the carbon dioxide of the air and the water of the sap in the presence of sunlight. It circulates through the plant as soluble carbohydrates or sugars, is stored in seeds, roots or stems as insoluble carbohydrates or starches. After digestion these are stored in small amounts as muscle, sugar or glycogen or are transformed and stored as fats or appear in milk as maltose (milk sugar) or as transformed butter-fat.

As a result of a long series of experiments conducted in many countries it has been found that a dairy cow weighing 1,000 lb requires for the best results a definite quantity per day of each of these ingredients in the food ration. If she gives no milk whatever, she will require what is called a maintenance ration and for each pound of milk containing 4 per cent. of fat she will require an additional ration.

In the case of a 1,000 lb cow producing 25 lb of milk testing 4 per cent. fat, the digestible nutrients required per day are stated by Henry and Morrison to be as follows:—

	Protein. lb	Carbohydrates. lb	Fat. lb
For maintenance	·77	7·7	·11
For 25 lb of 4 per cent. milk . . .	1·35	6·0	·52
Total ..	2·12	13·7	·63

If a cow has nothing to eat but para grass and eats 100 lb of it per day, which is a fair average allowance, she will, according to an average of the Government Chemist's analysis, take in 2·19 lb of protein, 10·91 lb of carbo-hydrates and ·32 lb of fat. Thus it is seen that she gets about the right quality of protein, not quite sufficient carbo-hydrates and only half the proper amount of fat. This is what is called an unbalanced ration in which the nutritive ratio is a little too narrow.

The nutritive ratio is obtained by dividing the proteins (2·19 lb in this case) into the sum of the heat equivalent of the fat plus the carbohydrates; for the purpose of this calculation the fat is multiplied by 2·25 because fat is about 2·25 times as good a fuel as are carbohydrates. Accordingly, the nutritive ratio for para grass is ·32 (fat) by 2·25 (heat equivalent) plus 10·91 (carbohydrates) ÷ 2·19 (proteins) which works out at 4·9 and the ratio is said to be 1 to 4·9 or 1:4·9. A good ration for a dairy cow is somewhere between 1:5 (narrow) and 1:8 (wide) so that the ratio for para grass is a little too narrow for best results. Moreover, the water and crude fibre content is high for this grass and therefore an unusually large quantity of this feed would be needed to supply a cow's needs.

If, on the other hand, a cow received an exclusive diet of sensitive plant (*Mimosa pudica*) she would, after consuming 100 lb in the 24 hours, have consumed 4·4 lb of protein which is more than twice as much as she requires, 12·35 lb of carbohydrates which is slightly short of the requirement and ·71 of a lb of fat which is somewhat more than she can use. Although the nutritive ratio of this diet 1:3·17 is too narrow for best results yet the figures show the very high value of the plant to dairymen in this Colony.

If we feed a mixture of half para grass and half sensitive the results work out as follows:—

	Protein. lb	Carbohydrates. lb	Fat. lb	Nutritive ratio.
50 lb Mimosa . . .	2·2	6·2	·35	..
50 lb Para grass . . .	1·1	5·45	·16	..
	3·3	11·65	·48	1:3·8

This gives our cow too much protein, with insufficient carbohydrates and fat.

By decreasing the proportion of sensitive plant the results are obtained as follows:—

	Protein. lb	Carbohydrates. lb	Fat. lb	Nutritive ratio.
25 lb Mimosa ..	1.1	3.1	.17	..
75 lb Para grass ..	1.7	8.2	.24	..
	2.8	11.3	.41	1:4.3

As in the case of the last mixture a cow would obtain slightly too much protein, close to the right quantity of carbohydrates and not quite enough fat, but on the whole the mixture would be fairly satisfactory.

This mixture can be improved by the addition of green ripe corn or maize that could be used to great advantage in June, July and August when para grass and sensitive plant are generally producing little herbage. A mixture suited to many dairy farms in this Colony would be:—

	Protein. lb	Carbohydrates. lb	Fat. lb	Nutritive ratio.
50 lb green ripe corn	.75	10.5	.4	1:15.2
25 lb para (pasture)	.55	2.7	.08	1: 5.24
25 lb Mimosa (pasture)	1.1	3.1	.17	1: 3.15
	2.3	16.3	.65	1:7

This mixture is a particularly good one and should produce more butter-fat in the winter months than does para grass alone in the wet season.

On those farms where Mimosa has not yet been introduced, a fairly satisfactory mixture for the dry months would be:—

	Protein. lb	Carbohydrates. lb	Fat. lb	Nutritive ratio.
50 lb of green ripe corn	.75	10.5	.4	15.2
50 lb of para (pasture)	1.1	5.45	.16	5.28
	1.85	15.95	.56	1:9.3

In order to use maize—dent corn is the best—as a soilage crop, that is to say, as a crop that is cut by hand from day to day and fed to the cows, it would be necessary to time three sowings so that the crops would ripen in June, July and August successively because the value of the crop is not nearly as good unless fed when in the ripe stage.

Another grass that shows up well in the analyses is *Paspalum dilatatum*. It is a better complete food than para grass because it supplies a larger amount of fat. It is, in fact, the best individual grass from a nutrient point of view on the table of analyses. This grass does well on the hill lands of Tailevu and when once properly established appears to compete favourably with the bush *Clidemia*. It is suggested, therefore, that each producer in this district would find it to his advantage to reclaim, we will say, two acres of hill land per annum and hand plant it to this excellent grass. Initial weeding would have to be done systematically, but once the plants had formed a cover the cost of maintenance would be very small. In ten years time such a practice would result in a substantially increased cream cheque for each farm.

The table which follows is worth careful study by dairy farmers. It represents a large amount of work on the part of the Government Chemist and will form a useful permanent record.

For comparison I have added analyses of dent corn, lucerne and meadow fescue and, for ease of reference, have included the essential content of the daily ration of a cow weighing about 1,000 lb producing 25 lb per day of milk containing 4 per cent. fat. As such a cow would eat about 100 lb of green food per day, the figures given in the columns can be compared directly with those in this column.

ANALYSES MADE BY THE GOVERNMENT CHEMIST OF SOME FIJI PASTURE PLANTS.

(Calculated on the fresh condition as newly picked.)

Name of plant.	% of protein.	% of carbohydrates soluble N free extract.	% of fat (ether extract).	Nutritive ratio.	% of water.	% of crude fibre.	% of ash.	% of lime (cao).	% of phosphoric acid p2 O5.
Paspalum dilatatum	2.51	11.02	.36	1:4.9	76.81	6.9	2.20	.10	.13
Paspalum conjugatum (local name, Thurston grass) Do. (a second analysis)	1.12	12.32	.35	1:11.7	75.9	7.53	2.58	.12	.18
Panicum barbinode—Para grass, sample 1	1.81	14.66	.41	1:8.6	71.5	7.9	2.91	.15	.19
Do. sample 2	2.00	8.19	.14	..	79.7	7.9	2.07	.06	.15
Do. sample 3	2.66	11.61	.43	1:4.8	71.5	11.68	2.11	.09	.08
Do. average of samples	1.91	12.93	.39	..	73.2	9.2	2.37	.10	.17
Panicum maximum—Guinea grass	1.51	7.6	.28	1:4.9	..	..	..	..	..
Stenotaphrum americanum, Buffalo grass, samp. 1 Do. samp. 2 .....	.99	6.92	.38	1:5.4	78.95	8.76	2.85	.19	.19
Eleusine indica—Tropical Crowfoot	1.21	6.43	.41	..	82.03	7.86	1.82	.091	.16
Eriochloa subglabra, Canb grass growing at Nasinu Pennisetum—Mission grass growing at Nasinu	1.91	11.58	1.1	..	83.61	7.45	1.76	.080	.13
Mimosa pudica—Sensitive plant, sample 1	2.3	7.3	.7	..	75.4	7.61	2.40	.07	.2
Do. sample 2	1.08	4.7	.4	..	81.8	6.0	1.9	..	..
Do. sample 3 (ends of young shoots only) Do. average of 3 samples	3.91	14.96	.72	1:3.9	63.4	15.11	1.9	..	..
Desmodium heterophyllum (a few plants are established at Suva)	3.80	13.90	.60	..	65.7	14.4	1.6	..	..
Micania scandens (mule-a-minute)	5.50	8.20	.80	..	74.9	9.0	1.6	..	..
*Medicago sativa—Lucerne	4.40	12.35	.71	1:3.7	..	..	..	..	..
*Festuca pratensis—Meadow fescue	2.8	11.01	1.05	..	74.69	7.66	2.81	.21	.31
*Green dent corn (in condition to feed as a soilage crop) .....	.77	13.80	1.55	..	76.85	5.04	1.99	.09	.11
*The ration for a 1,000 lb cow producing 25 lb of milk containing 4 per cent. butter-fat should contain	4.5	10.4	1.0	..	74.7	7.0	2.4	.35	.25
..	3.0	14.0	1.0	..	69.5	10.1	2.4	..	..
..	1.0	12.8	.4	1:13.7	..	..	..	..	..
..	2.12 lb	13.7 lb	.63 lb	1:7	..	..	..	..	..

* From Henry and Morrison.

LANTANA BUG "TELEONEMIA LANTANAE, DISTANT."

Report by the Government Entomologist to Superintendent of Agriculture on a mission to Honolulu to obtain the Lantana Bug "*Teleonemia lantanae*, Distant."

NOTE BY THE EDITOR.

ON page 10 of the last number of this *Journal* a note was printed concerning the proposal to introduce the insect mentioned in the title of this article. As the insect has now been successfully introduced, it seems desirable to bring all the information concerning this project together so that it will be available for future reference. The initial step was taken as a result of a Council Paper written by the Superintendent of Agriculture and, as this Paper is short and may not have been seen by the planting community generally, it is reprinted here for reference.

It is too early as yet to say what value, if any, the *Teleonemia* will have in this Colony, but Mr. Simmonds' report shows that a sufficient number have been introduced to give the insect every possible opportunity of increasing rapidly.

A reprint of the Council Paper No. 35 of 1928 is as follows:—

Some years ago when lantana had become a very serious weed in the Colony of Fiji Mr. Jepson, then Government Entomologist, was authorised to proceed to Hawaii in order to examine the work that had been done by the Hawaiian authorities towards controlling the same weed in that territory by the introduction of insect enemies. As a result of his inquiries he successfully introduced a small fly *Agromyza lantanae*.

A few years later the then Acting Government Entomologist, Mr. Simmonds, introduced two butterflies falling under the family *Lycaenidae*, namely, *Thecla echion* and *T. bazochi*, the larvæ of which were known to feed exclusively upon lantana and particularly upon the flowers.

The Government Entomologist now reports that the position in Fiji at the present time is as follows:—

"*Thecla bazochi* is now generally distributed around Suva and Levuka, but is not locally as abundant as shortly after its introduction.

Thecla echion was liberated on Taveuni, but whether established is uncertain.

Agromyza lantanae is everywhere."

The following summary of the position in Hawaii as at September, 1924, is taken from Mr. O. H. Swezey's Bulletin No. 16 of the Hawaiian Sugar Planters' Association. Several insects introduced into Hawaii for the purpose of controlling lantana between the years 1902 and 1905 were—

generally spread throughout the islands of the group and have continued their work in more or less checking the lantana, the effectiveness depending on climatic and, perhaps, other conditions in the various regions. In some places this is due to the combined work of the insects, successive prolonged dry periods, and to the presence of cattle. Where lantana is cleared from the land for grazing or agricultural purposes, it does not usually again take possession if the land is abandoned and allowed to revert again to natural growth of weeds or bush. Instead of lantana reoccupying such lands, several other kinds of shrubs or trees have taken possession, some of them much more difficult to eradicate than was the lantana.

From this statement and from what I personally saw of lantana in Hawaii in December, 1924, it seems clear that the degree of control of lantana in

Fiji at the present time is considerably less than that in Hawaii. The question therefore arises as to whether further steps could not be taken to improve the local position. There is a small insect in Hawaii called *Teleonemia lantanae* belonging to the family *Tingitidae* that feeds upon the foliage of lantana and becomes so numerous occasionally as to completely defoliate the plants. Steps have not been taken hitherto to introduce this insect on account of the possibility of its feeding on some other plant of economic importance. As it has now been established for a number of years in Hawaii a letter was sent recently to Mr. O. H. Swezey, the entomologist to the Hawaiian Sugar Planters' Association, asking him to be so good as to give an outline of the present status of this insect in the territory under his control. His reply, dated April 29th, 1928, is as follows:—

As to your inquiry about the lantana bug, *Teleonemia lantanae*, having any objectionable habits. Here in Hawaii it has not been known to breed on any other plant than lantana. It often infests lantana over great areas, and the young develop so abundantly on the under side of the leaves that their feeding destroys the leaves. The whole area of bushes will look as though dead. They are not dead, however, but their growth has been checked, and blooming prevented. Thus the bug is a factor in preventing seed production. When the infected leaves fall from the bush before the nymphs have matured, no doubt many of them die. Those that have matured migrate to other lantana areas. Often the adult bugs may be found scattered on many other plants, possibly feeding on them slightly, but such feeding is not of any consequence. They do not oviposit in anything but lantana. No infestations have been found on anything but lantana.

If you are considering the introduction of this bug to Fiji I should say from the experience here, that it is entirely safe, and that it would be a factor in checking seed production. It would not kill off the plant however. Here, after the lantana has been defoliated by this bug, the bushes will have a dead appearance for a time, but eventually make a fresh, new growth. Of course, if it should be a long dry time, this new growth does not take place so soon, and there is some dying back of the tips of twigs.

In view of this statement from so reliable an authority I consider that it would be safe to introduce this insect into the Colony of Fiji.

REPORT BY MR. H. W. SIMMONDS.

Acting under instructions received I left Suva by the s.s. "Ventura" on 20th September, 1928, to proceed to Hawaii in order to obtain and endeavour to establish in Fiji the *Tingid* bug, *Teleonemia lantanae*, Dist., which had been introduced into that country by Koebele from Mexico in 1902, and which, it was hoped, would prove a valuable additional check upon the spread of the weed in these islands.

At Honolulu I was most kindly met by Mr. O. H. Swezey and Dr. Williams of the Entomological Staff of the Hawaiian Sugar Planters' Association. These officers and the officers of the Department of Agriculture and Forestry and also Dr. Illingworth of the Pineapple Growers staff did everything in their power to help me, constantly placing their motor cars at my disposal, driving me to various likely places to locate the insect that I desired and later, when located, assisting me to collect the quantity required for shipment.

Condition of the weed lantana in Hawaii.

The weed *Lantana camara* is generally distributed throughout Oahu, in many parts covering considerable areas. As a general rule it is stunted as compared to Fiji, but in the mountain valleys and other favourable parts seems as vigorous as is usual in this country. How far the general stunted appearance is due to insect attacks and how far to the drier climate I would

not like to say, I am, however, informed that it has disappeared from many areas where it was formerly abundant. Unfortunately, it has, in certain places, been replaced by other and even more noxious weeds, chief of which are *Acacia farnesiana* and guava, both present in Fiji.

At the time of my visit the weather was very dry and large areas of lantana were completely defoliated. Most of this defoliation was due to a recent attack of the bug *Teleonemia lantanae*, which is now being introduced into this country. The defoliation caused by this bug makes its attacks the most conspicuous of those caused by the insects introduced by Koebele in 1902 for the control of the weed.

Of the other insects introduced and established at that time two *Thecla agra*, a flower-eating butterfly, and *Agromyza lantanae*, a seed destroying-fly, have already been successfully established in Fiji, whilst *Thecla echion* was attempted on Taveuni but it is not yet known whether it is established on that island. In addition to the insect now being introduced three moths and a gall-forming fly have as yet not been attempted.

Whilst the recent work of the leaf *Teleonemia* was very much in evidence throughout the island of Oahu it was difficult to find it actually present, only two active outbreaks being discovered, with here and there a few odd scattered specimens. These two outbreaks were situated, one about 40 miles from Honolulu and, a large one, in a mountain gully about 28 miles away. In both of these places the bug was extremely numerous and I collected between 10,000 and 12,000 to bring away with me.

Action of bug on plant.

Both adults and nymphs suck the juices of the leaves and young stems and to some extent the flower buds. Older leaves, when attacked, become covered with pale spots due to the removal of the contained juices, whilst younger leaves generally develop a curled contracted look and, both old and young, dry up and drop to the ground. The attacks necessarily reduce the capacity of the plant to produce flowers and seeds, although not actually killing it.

The life history of the bug has not yet been worked out and the eggs are unknown, but the bugs bred freely in my cages, both in Hawaii and on the voyage to Fiji.

Of the lantana insects not yet brought to Fiji the *Crocidosema*, causing a certain amount of dieback, is probably the most valuable, but the gall fly is also conspicuous in its work. Both of these insects, however, by causing dieback of the terminals, lead to lateral branching and I am inclined to think are largely responsible for the matted growth of the plant in Hawaii as compared to Fiji, in which case they would hardly be desirable.

Collection and transport of bugs.

In order to transport the bugs to Fiji sixteen lantana plants had been kindly planted in tubs, in quarantine, by the officers of the Sugar Planters' Association. Those were placed into large cages, $2\frac{1}{2}$ ft. by $2\frac{1}{2}$ ft. by 6 ft. high, and insulated from ants.

As it was found that the bug would breed in the cages it was decided to adopt the method of loading principally adults, a total of 8,000 being collected, which were divided between the six cages, whilst a further 2,000 were placed in glass mason jars to be fed daily by hand on the voyage.

Both methods proved satisfactory so far as the transport of the bug was concerned and, on arrival in Suva, they were present in all stages and great numbers, 8,500 having been transferred by the 22nd with still more uncounted to come.

Arrival and liberation in Fiji.

Fiji was reached on November 1st at noon and that afternoon 500 of the adults, which had travelled in the mason jars, were liberated on Circular Road.

Next day two cages were prepared with local plants and loaded up with 1,550 adults, whilst a further 1,500 adults were released at Tamavua and Circular Road.

On November 7th, 1,150 nymphs were collected from the three cages which had been longest in use and transferred to local plants in another cage and the imported plants fumigated, the soil being afterwards dumped into the sea. The remaining cages were similarly treated ten days later, after the collection of the majority of the remaining nymphs.

Liberation.

In order to prevent the introduction of any undesirable insects all material for liberation was collected in the adult stage only, and from a white surface. It was placed in tubes of 100 to 200 and carefully gone over with a lens before being released.

A total of 4,000 adults have, up to date, been freed in the Suva district, viz., Samabula, 500; Reclamation, 150; Tamavua, 1,900; and Circular Road, 1,500. Colonies are now being prepared for liberation elsewhere in the group.

Recovery of bugs in field.

On November 19th newly hatched nymphs of the bug were observed at the Tamavua and Circular Road colonies, whilst they were also present in the breeding cages at the office. On November 22nd nymphs were numerous at Tamavua, but the Circular Road colony was less satisfactory.

Other parasites brought back at same time.

There are in Hawaii a number of other parasitic insects, mostly imported, many of which should be of value to this country and the introduction of certain of these was attempted on this occasion. Limited attention only, however, could be given to these, as it was necessary to ensure the success of the main objective.

House and Sarcophilid fly parasites.

A quantity of material was collected in the hopes of obtaining parasites which would attack cow dung breeding *Diptera*. I was, however, unfortunate in that the material which I obtained proved to be mostly unparasitised, although as high as 80 per cent. parasitism of the horn fly, which breeds in cow dung and whose parasite also attack house flies, has been obtained. Mr. Fullaway of the staff of the Agricultural Department at Honolulu has, however, kindly promised to endeavour to get a pure culture of these on house-fly puparia and forward when available.

Banana Scab Moth (Nacoleia octasema.)

Although this moth does not occur in Hawaii, *Nacoleia (omoides) blackburni* on coconuts and bananas and five other species of *Omoides* are known,

all being heavily parasitised, and it was thought that some of those parasites would possibly attack *N. octasema*. The chief parasites are:—

- | | |
|------------------------|-----------------------------------|
| 1. An Ichnumonid | <i>Cremastus hymeniae</i> . |
| 2. A Braconid | <i>Microbracon omiodivorium</i> . |
| 3. A Chalcid | <i>Chalcis obscurata</i> . |
| 4. A Tachinid .. .. | .... |

Egg parasites and occasional other *Ichnumonidae* are also bred from the same hosts.

I was unable to obtain the *Tachinid*, which had, however, at one place been numerous shortly before my visit.

Of the Chalcid I obtained about 25 and these in captivity were found to attack the pupae of *N. octasema* freely and also of the cotton pest *Sylepta derogata*. These will be liberated only if it can be proved that they will not attack *Ptychomyia* before liberation.

The *Braconid* was very numerous and about 200 were brought through. About 150 of these were liberated near Tamavua, the balance being used to try to breed in captivity. This proved unsuccessful as they became entangled in the webs spun by the *Nacoleia* and *Sylepta* larvae in the tubes and jars, so I liberated the balance in my garden, where I hope they may find sufficient *Hymenia fascialis* to establish themselves.

The *Ichnumonid*, *Cremastus hymeniae* is, however, the one most likely to prove of value and of these I was only able to bring 16 adults. Only two of these were males, and these were not observed to pair in the tubes. On arrival they were all placed in a big cage, with several bunches of bananas affected by the scab larvae. They became most interested, hunting over and around the bunches, but an accident necessitating opening of the cage, it is probable that some escaped. In any case none were bred through. This parasite has, in Hawaii, been bred from all six species of *Omoidea*, also from 20 other lepidopterous larvae and is at times extremely numerous on *O. blackburni*.

I feel that *Cremastus hymeniae*, the *Tachinid* (the name of which I omitted to obtain) and the *Microbracon*, if not established, are all desirable. Mr. Swezey has kindly promised to endeavour to obtain the first for us when he comes across it in quantity. The fact that its principal host is a banana insect (as well as coconut) and its varied list of hosts and, that it is at times extremely numerous on *Nacoleia blackburni*, make it offer decided possibilities against *N. octasema*. There is also an egg parasite of *N. blackburni* which might be of value, but which I did not come across on this occasion.

Ladybird (Azya luteipes).

About a dozen examples of this ladybird, which destroys *Lecanium* scales survived the journey and were liberated upon a patch of *Lecanium* in the office grounds.

OTHER VALUABLE INSECTS IN HAWAII.

Nut Grass Enemies.

Two enemies to this pest are now established in Hawaii, one, a moth, being widely distributed and may prove to be the same as one in Fiji. I have not yet had an opportunity of comparing them and it appeared to be a little larger.

The second is a beetle and, at present, is confined to one or two small areas. It should eventually prove the more valuable of the two, as it is more destructive in its effects.

Rose beetles.

Considerable efforts are being made against this pest, and a *Tachinid* which attacks the adults is now being introduced.

SUMMARY OF POSITION ON 27TH NOVEMBER, 1928.

Teleonemia lantanae.—9,450 specimens of this bug have now been collected and transferred from the introduced material. These were dealt with as follows:—

- 1,075 sent to Suvasavu on 26/11/28.
- 160 liberated on Reclamation on 15/11/28.
- 500 liberated at Samabula on 14/11/28.
- 1,900 liberated at Tamavua on various dates.
- 1,550 liberated at Circular Road on various dates.

5,185 total liberated to date.

The balance are being used to breed in captivity, but a colony of 2,000 is being collected to take to Taveuni on 29th November, 1928.

2. I am of opinion that all my cages are now, so far as imported material is concerned, clean. One cage is, however, a contact, and that will be fumigated after the bugs are withdrawn as they become adult. When this is done I shall be able to report the actual numbers imported.

3. Owing to probable lack of food during my absence I propose to liberate a further number locally before I proceed to Taveuni.

Chalcis obscurata.—This was tested against *Ptychomyia*, and whilst, in one case, it appeared to have stung one, none have as yet bred through. It was, however, found that there was a considerable pupal parasitism, 20 to 25 per cent., of *Nacoleia octasema* from a dark winged local *Chalcid* and, as it was unlikely that a second species would materially increase this, it was decided to destroy the introduced one and this has been done.

VISIT TO TAVEUNI BY GOVERNMENT ENTOMOLOGIST.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

THE main object of this visit (November 28 to December 10) was to liberate a Colony of the imported lantana insect *Teleonemia lantanae* in a suitable locality on Taveuni.

2. Headquarters were made at Waiyevo where there was a fine stand of lantana. It was found, however, that this area was isolated, the weed not extending southwards, whilst northwards it did not seem to go beyond Bucalevu.

3. I was informed that there were considerable areas about St. Heliers in the north and also from Ura southwards at the other end of the island. I decided to liberate the bugs at Ura, selecting a well-sheltered hollow at the back of the estate on the Selia Levu road, and this was done on Saturday afternoon, 1st December, 1928.

4. The colony, which consisted of 1,100 adults and 1,100, nymphs seemed to be in extremely good order when set free.

Scale Aspidiotus destructor.---Whilst waiting for the return of the "Makatea" careful search was made, over a limited area, for this pest. The native villages of Somosomo and Bucalevu were worked, as were the plantations as far south as Wairiki and a day was spent in the big bush. Particular attention was given to the various species of *Piper*, also to Kavika and Vutu, whilst bananas and coconuts were carefully watched. Nowhere was anything seen to suggest the presence of this pest on the island.

[NOTE BY THE EDITOR.---As the three plants mentioned are amongst the favourite food plants of this insect, it can, I think, be taken for certain that the scale has not yet reached Taveuni. Taveuni planters should therefore be particularly careful to prevent the landing of infected kava roots from Vanualevu in parts of which this scale is now extremely abundant.]

SOME EXPERIMENTS TO ASCERTAIN THE PART PLAYED BY FLIGHT IN THE DISPERSAL OF THE BANANA BORER *COSMOPOLITES SORDIDUS* IN FIJI.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

AN INTRODUCTION BY THE SUPERINTENDENT OF AGRICULTURE.

It is now generally recognised that the banana borer *Cosmopolites sordidus* is the most important pest of bananas in this Colony and that no steps of much importance can be taken toward improving plantations that do not provide for the control of this beetle.

The beetle breeds chiefly in the base of the old stumps and spreads in due course to the corms of the green trees in the same clump. In the campaign now being conducted for cleaning up the old plantations special stress is therefore placed in the destruction of the old stumps.

When it comes, however, to planting new areas it is advisable to use clean suckers, and at present there is no reserve of clean suckers from which to draw and no satisfactory method of establishing such reserves has been developed.

As a preliminary step one must know how long a clean nursery can be expected to remain free from beetles because it is no use to go to the trouble and expense of establishment if beetles find their way in within a few months.

The question as to how this beetle migrates is therefore of considerable importance to the banana grower, and with a view to obtaining some definite information on the point the Government Entomologist was asked to carry out certain experiments, the results of which he records in the following article together with the results of an earlier experiment carried out in 1921.

The experiments cannot be regarded as conclusive, but as far as they go appear to show that although the beetle flies, its migration by flight is practically negligible and that a clean nursery would become infected very slowly by beetles crawling in from neighbouring plantations.

ACCOUNT OF THE EXPERIMENTS.

The borer lays its eggs in tiny pits in the corm of the banana, the newly-hatched larvae boring into the heart of the corm. In this position they are almost immune to the action of either poison or fumigation. It is in this

way that eggs and young larvae are generally transported in the young suckers to new plantations and it is these transplanted larvae which cause the majority of the misses when planting up new land. If growers could be induced to pull up all affected suckers and burn them immediately they are observed, through failure to grow, to be attacked, they would, in my opinion, considerably increase the yield of their estates.

It is also by means of infected suckers that new areas become infected and it therefore becomes a question whether, provided clean suckers could be obtained, the beetle has other sufficient means of dispersal to quickly infect such new, clean areas. This leads to the question as to what part flight plays in the dispersal of the pest.

Flight.—The adult beetles have well-developed wings, but they undoubtedly travel on the estates mostly by crawling, and authentic records of flight are exceedingly meagre. The following are all I have been able to collect in Fiji:—

Date.	Locality.	Authority.
12-11-23	Specimen found on dining-table, Suva	G. H. V. Saunders.
2- 7-24	„ dining-table, Suva	C. T. McNamara.
*14-11-27	„ on electric light post, Suva ...	H. W. Simmonds.
*23-12-27	„ in kitchen, Suva	H. W. Simmonds.
22- 4-28	„ settled on head but lost, Suva .	G. H. V. Saunders.

* Both empty females.

McDonald states that between 1910-1914 he had had them bang against his mosquito gauze, perhaps a dozen times. The above records all lack something definite, but more satisfactory information is available elsewhere, as follows:—

Date.	Locality.	Authority.
12- 4-24	At Buderin, Queensland	F. W. Froggatt.
23-11-24	A male caught in flight at Valdora, Queensland	„
25-11-26	At Buderim a male flew onto a table	„

At La Brea in Trinidad one was actually captured in flight by F. W. Urich, whilst two others were taken at light.

These observations seem to leave little doubt but that the beetle does, on occasions, fly and the question as to what extent flight is a factor in the dispersal of the pest becomes of the utmost importance in trying to devise methods of control. If it can be shown that flight seldom takes place, then it would be possible, by using clean suckers and planting clean land, to obtain good crop returns before the pest reached the area in sufficient numbers to cause appreciable damage.

Experiments.—With these objects in view the following experiments were carried out:—

As far back as July, 1921, I carried out the first experiment in the back of the old Agricultural Department in Hercules Street. Suckers were obtained from heavily borer-infected Java, Cavendish and Lady's Finger plants. These were scrubbed and carefully examined, and of these 4 Java,

2 Lady's Finger and 3 Cavendish seemed to be free from the pest and were planted out. Within three months three of the Javas and two of the Cavendish showed by failure to grow and general yellowness, that, despite these precautions, borer was present. These were then dug up, when it was found such was the case and they were burnt. This burning was effective, destroying all borer present, the remainder going ahead well. When, during the following year, suckers were removed, no trace of borer could be detected. The land then passed from the control of the Department, some time after which the Lady's Fingers were removed. The Cavendish remained, however, and, as late as February, 1926, the main tree and one of its suckers produced twelve hand bunches. A year later, however, there was a marked falling off, borer was found to be present and the bunches were reduced to six hands. The above experiment demonstrated that the dispersal of the borer other than by infected suckers is slow, and that in its absence the plants yielded 100 per cent. increase.

Second Experiment.—This experiment was undertaken to try to find if flight was habitual or only occasional, the following method being adopted:—

On December 28th, 1926, 15 adult *C. sordidus* were placed into a flat tray, having upright sides, with about one inch of soil at the bottom. In order to make sure that the beetles could not get out by climbing, a ring of tangle-foot was placed round the top, whilst as a further precaution the whole tray was insulated by water covered with a film of oil. The trays were placed on a table in the big insectary and pieces of cut banana corm laid around upon the table to tempt them to leave the tin. This of course they could only do by flight.

For the first ten days the soil was kept moist, after which it was allowed to dry off. Whilst it was moist the beetles were very sluggish boring into the damp soil and remaining more or less in a mass during the daytime. As soon as it dried up, however, they came to the surface and crawled about, trying to climb the sides, but so far as could be seen no attempt to fly was made. They were also given a stick to be used as a jumping off place, but no attempt appeared to be made to use it and after 20 days the experiment was abandoned, all the beetles being still present in the tray. The weather conditions for this experiment were ideal, with many moist warm nights.

Field experiments.—It was then decided to carry out a field test to see if flight was, under natural conditions, a factor to be taken into serious consideration. Land was prepared at Mr. Calway's Nursery at Lami and about a hundred eyes placed in sand to obtain borer-free stock. This was so far successful that the proportion of infection was reduced to about five per cent. The cleared land had had bananas on it, and other badly-infected stools adjoined, whilst abandoned plantations occurred 50 yards and again 250 yards away. Borer was heavily present in the old plants around. It will thus be seen that there was an abundant supply of the pest to infect clean suckers, if such were planted in the neighbourhood.

The plan was to plant out thirty suckers in such a way that borer could only reach them by flight and a further thirty under normal conditions to act as a check. There was of course a possibility that the pest might be present in the soil and this would have to be taken into account in any infection which might be found to be present in the protected plants. As a precaution against any such being present the soil was fumigated where the protected plants were to be placed, with carbon-di-sulphide. I have reason, however, to consider this fumigation was ineffective as slugs and other organisms were found to have survived it.

As stated above, in order to obtain clean suckers, about 100 eyes were taken, carefully examined and set in sand by Mr. Calway. These were carefully gone over as soon as they were set and sixty, apparently sound ones, selected. Thirty of these were planted in large galvanised cylinders, bent over at the top rim and sunk, twelve sunk six inches and eighteen of them eighteen inches into the ground. Around the top of each cylinder, and under the protection of the inverted rim, a ring of tanglefoot was placed and renewed as occasion required. This, in my opinion, should effectively prevent any borer reaching the contained plants, except by flight. Beside each cylinder another clean sucker was planted, unprotected in any way, to act as a check. The plants were laid out in four plots planted as follows:—

Plot I ..	Planted March 8th, 1927 ..	6	protected,	6	checks.
Plot II ..	Planted April 29th, 1927 ..	8	„	8	„
Plot III ..	Planted May 11th, 1927 ..	12	„	12	„
Plot IV ..	Planted May 19th, 1927 ..	4	„	4	„

The plants were allowed to grow until the end of the normal wet season following, being dug up and examined on April 20th and 21st, 1928.

Result of experiment.—It was observed that (probably owing to the extreme paring which had been necessary to be sure that no borer was present) the original bud remained in most cases as a bulb, the plant growing above it, the original rootlets having formed at the neck of the bulb whilst the bulb itself had rotted and turned black. When dug out and examined the thirty protected plants showed 28 absolutely healthy. There were however two plants (Plot I, No. 2: and Plot II, No. 6) in which the original bulb, which was black and dead, showed signs of insect attack, but whether by borer introduced with the original sucker or later by scavenger I could not say. In any case the growing plant was clean as the remaining 28 and it is certain no borer had reached any of these plants by flight.

The check plants.—One of these (Plot III, No. 9) was removed twenty days after planting owing to borer, undoubtedly present when the sucker was planted out. Six showed a similar condition to the two in the protecting rings, having had insect attacks, confined to the original decayed bulb only. Of the remainder, seven were found to have been attacked, whilst sixteen were absolutely clean.

Summary of results of experiment No. 3.—The details of the plots will be shown as an Appendix. Seven of the check plants definitely became infected; one other undoubtedly had borer when planted out, whilst of the seven doubtful cases (2 protected and 2 unprotected), which I at first thought showed traces of having had borer in the original bulb, I now think more likely to have been the work of other agencies, which would attack the bulb after death.

I am of opinion that these experiments show—

1. that flight as a factor in the spread of borer is practically negligible;
2. that the borer undoubtedly crawls, as was well known, but that such crawling is not nearly to the extent supposed, and that if clean suckers are used infection would be slow in reaching injurious proportions;
3. that it is most difficult to obtain borer-free suckers by mechanical means and that it is almost entirely by means of infected suckers that new estates become borer infected.

Experiment No. 4.—In connection with this latter result another experiment was carried out. On September 21st twenty-four sturdy suckers, which, however, had not been specially selected for absence of borer, were chosen. Twelve of these were immersed in 1 per cent. solution of formaldehyde for 20 hours. These were then planted out in Plot V adjoining Plots II, III and IV, together with the twelve undipped plants alternating as checks. Of the dipped plants five died completely, whilst in two others the original sucker died, but threw out a bud which grew. When dug up it was found that of the seven survivors five were clean and two had borer. Of the undipped check plants four were clean and eight had borer.

Conclusion.—These experiments have, I think, shown that, although flight does probably take place at times, it is a minor matter in the spread of the pest. They have also shown that the borer is generally sluggish in its habits and is fairly content to stay where it has abundant food. So that if a scheme could be devised to supply growers with clean suckers they would be assured, if they planted on clean or moderately clean land, of a reasonable crop before their estates were seriously affected by the pest.

APPENDIX.

BANANA EXPERIMENTAL PLOTS.

Plot I.—This was the original plot and was laid out with twelve plants. Six of these were in the cylinders and alternated with six check plants in the open. The land had had old banana stumps present before clearing to plant up. Of those plants protected by the cylinder, one was found to have had an insect attack in the original bulb used as a sucker and if borer little doubt was introduced as an egg or minute grub when the plants were put in. In view of others examined later I think, however, this was more likely to be work of some scavenger. All the other plants were healthy and all were beautiful plants. Of the unprotected check plants, one was infected with several borings, whilst a second showed traces in the original bulb similar to the protected one and is, I think, the work of a scavenger. The other four were undoubtedly clean.

Plot II.—This plot consisted of sixteen plants, eight protected by cylinders and eight alternate unprotected checks. As in No. I plot one protected plant had had traces which may have been a single borer in the original bulb or a scavenger, all the rest were clean. Of the eight unprotected checks, three showed traces of borer, one being a heavy infestation, but one of the others was in the original bulb only and like the others seemed more like the work of a scavenger.

Plot III.—In this plot one bulb was removed with borer present on 31st May, 1927, twenty days after planting, and undoubtedly present when put in. When dug out all the plants of this plot in the cylinders proved to be absolutely clean. Of the check plants five were clean, three showed the same insect attack on the original bulb mentioned previously, and three were definitely attacked by borer.

Plot IV.—This plot consisted of eight plants and adjoined two old stumps, one of which was rotten with borer. It was naturally expected that it would prove to be heavily attacked. This, however, proved to be not so.

None of the four protected plants were attacked and only two out of the four check plants were infected (one of these in the original bulb only and more likely the work of a scavenger).

Odd plants.—An old odd plant adjoining plant 3a in Plot No. IV was rotten with borer, as were several near Plot I.

A NOTE ON THE AIR SAC MITE DISEASE OF POULTRY IN SUVA.

By CHAS. R. TURBET, B.V.Sc., Senior Government Veterinary Officer.

A SERIOUS mortality of fowls has recently occurred in Suva. Investigation by the Veterinary Division of the Department of Agriculture resulted in a diagnosis of Air Sac Mite disease being made.

The complete life history of the minute mite, which has the name of *Cytodites nudus* and causes this disease, is not known. The mite, however, gains entrance to the body of the fowl by way of the air passages and lives in the large air spaces in the body of the fowl wandering freely on the membranes. It produces disease by irritating, carrying of disease germs and possibly by the production of a poison in their own bodies which acts on their host. When it exists in large numbers between the lung and the chest wall and in the lung tissue it produces pleurisy or pneumonia or pleuro-pneumonia and causes the death of its host.

The mites cannot occur spontaneously in a fowl run but must be brought there by the introduction of infected birds into the flock.

Control measures.—In introducing new birds into the fowl-run care should be taken that they come from a flock which is above suspicion. New birds should also be isolated as a precautionary measure. The fowl run should not be overcrowded as the chance of spreading infection is greatly increased thereby. When a flock is already infected it is debatable whether it is more economical to kill off all the fowls, leave the run unoccupied for a time, and then start with new birds, or to kill off obviously infected ones only and treat the flock. If the first method, which is certainly disheartening, is adopted one will be tolerably sure of clearing the disease from the run. If the second method is adopted one might expect periodical outbreaks in the flock with a limited mortality after the first serious outbreak has subsided. When the second method is adopted, treatment might consist of general improvement in the sanitary condition of the fowl-run such as whitewashing with whitewash containing 5 per cent. carbolic acid, liming the soil with fresh lime or chloride of lime, cleaning up rubbish, provision of good water supply and provision of fresh grit. A desert spoonful of sulphur mixed in the mash food for a dozen birds is the best known medicinal treatment for the Air Sac Mite disease of fowls.

A FIBROMA ON EQUINES IN FIJI.

By W. G. BENNETT, B.V.Sc., Government Veterinary Officer.

THE condition, known locally as Fiji Sore, is quite common among horses in this group, and also in Rotuma. Fairly close study has failed so far to reveal the etiology of the disease, but the history in nearly every case seen suggests that it is caused by an eroded or cut integument that is permitted to remain unhealed, and that is subsequently worried by flies.

In Fiji it is usually seen where horses are kept or worked in muddy or swampy land, but in Rotuma, which has little or no mud, the majority of cases occur on the leeward side of the island. Here the flies are particularly bad, and are suspected of being either casual agents or carriers.

No bacteria have been found in smears made with liquid from a cut surface, but sections demonstrate the presence of a large mass of fibrous connective tissue without blood or other vessels present but with a large number of giant-cells present. This is suggestive of fungus infection by a species of *Sporotrichum*, but no mycelia or fungal threads have so far been discovered. On the other hand it is also typical of a simple fibrous tumour due to severe irritation following upon a failure to dress wounds. In the examinations made no signs of any nematode worms were noted.

Although the cause of this disease has not been definitely ascertained it is clear that strict attention to cleanliness and dressing of wounds on horses are indicated. The application of copper sulphate (Blue-stone) to any tumours which develop can be safely recommended, but the application must be made in the early stages of the tumour, and when made any scabs that may have formed should be removed. Surgical interference has been found unreliable and to give varied results.

SULPHURING OF COPRA.

By COLIN L. SOUTHALL, B.Sc., A.I.C., Government Chemist.

SOME ten years ago extensive experiments were carried out by the Philippine Bureau of Science in regard to the effect of sulphuring copra prior to drying with sulphur dioxide gas. The results published by them were encouraging and it was decided to make experiments in Fiji in the hope that the method would be of use in improving the quality of copra produced.

Accordingly a small gas-tight chamber fitted with sliding trays was erected on Mr. de Mouncey's estate, Wakaya. Freshly cut copra was placed on the trays and sulphur equivalent to 9 lb per 1,000 cubic feet air space burnt in a shallow tray on the floor of the chamber, the door being closed for four hours. Various experiments were made, the most severe being the following:—

A tray of sulphured and a tray of unsulphured copra were placed in a damp concrete shed. Corrugated iron was laid over the trays to prevent rapid drying. Each night the iron was removed and the copra sprinkled with rain water. After eight days of this treatment the sulphured copra was white and free from moulds while the unsulphured copra was a slimy green mass. Both samples were placed on open vatas and sun-dried for three days. The analysis of the two samples was:—

	<i>Sulphured.</i>	<i>Unsulphured.</i>
Moisture	5.9 per cent.	5.1 per cent.
Free acid (as Oleic) ..	0.34 per cent.	9.6 per cent.
Colour of oil	White	Light brown.
Appearance of copra ..	White	Very mouldy and brown.

A sack of the sulphured copra was shipped to San Francisco for valuation. The Pacific Oil and Lead Works reported:—"This is about the finest grade of copra we have ever seen and if this quality could be maintained on regular shipment it would bring a premium of at least one-eighth cent. per lb over

good grades of sun-dried copra now arriving in this market." The premium quoted is equivalent to 11s. 6d. per ton of 2,240 lb which is disappointing.

Partly in consequence of the above satisfactory experiments Mr. James Harper of Taveuni made a large scale experiment on his plantation. He built a chamber with a capacity of 4,000 lb wet copra. For a number of reasons the sulphuring was not as efficient as in the smaller box. The conclusions arrived at as a result of these and the previous experiments were:—

1. Sulphuring of copra enables a first-grade copra to be made on open or running vatas even when heavy rain falls on the copra.

2. Sulphuring of semi-dry copra that is rapidly deteriorating prevents any further loss by mould action.

3. Sulphured copra will not dry out into first-grade copra when kept under cover in a poorly ventilated shed. (This does not agree with the results reported in the Philippines).

4. Sulphuring of copra entirely prevents the "burning" of copra on open vatas in hot weather.

6. The actual cost of the process is not heavy. The small premium of 11s. 6d. a ton quoted would probably be absorbed by labour and interest on the chamber, but it should be taken into account that careful experiments have shown that there is a loss in weight of $12\frac{1}{2}$ per cent. when copra is prepared by the ordinary open vata method, a considerable proportion of which would be saved by sulphuring. Furthermore, there is a danger of further price discrimination against bad grades of copra.

7. Sulphuring may, therefore, be said to be of considerable advantage to small producers, particularly those situated in wet districts who are not in a position to install mechanical driers. No details in regard to the actual type of chamber, &c., are given here because a further test is being made shortly with what is hoped will prove an efficient yet cheaply erected chamber.

DETERIORATION OF COPRA ON STORAGE.

By COLIN L. SOUTHALL, B.Sc., A.I.C., Government Chemist.

EXPERIMENTS carried out during the winter of 1927 to determine the loss caused to copra by drying on open vatas pointed to the fact that further loss occurred after the copra was removed from the vata to storage. To determine if possible the condition resulting in loss and the amount of loss the following experiments were made:—

- (a) Change in acidity of three commercially prepared samples of copra;
- (b) slow drying of copra on open vata for 14 days followed by three months' storage;
- (c) storage of commercially prepared copra for three months and estimation of loss at intervals;
- (d) rapid drying of copra on open vatas and removal to storage for three months.

(a) *Change in acidity on storage.*—The loss of copra was unfortunately not determined, but nevertheless the results are of interest:—

Copra.	23-10-27.		10-12-27.		7-1-28.	
	Water.	f.f.a.	Water.	f.f.a.	Water.	f.f.a.
1	9.1	4.6	4.9	12.2	4.7	11.8
2	7.1	2.9	4.8	4.2	4.7	4.4
3	7.4	2.1	4.8	4.9	4.6	4.9

The copra arrived in Suva on 22nd October, 1927, for shipment to Europe. Sacks of each brand were held back and stored with other copra in a bulk store, being examined at intervals.

(b) *Changes during slow drying on open vatas for 14 days followed by storage for three months.*—On the 14th day the copra was bagged and stored with other copra:—

	Slow drying on open vatas.		Storage in presence of other copra.	
	1st day.	14th day.	55th day.	99th day.
Moisture	45.6	8.0	4.8	4.6
Oil content of anhydrous copra ..	68.4	69.9	70.6	70.4
Acid in oil (as oleic)	0.2	6.5	9.9	9.8
Loss anhydrous copra .. ..	..	10.9	14.6	15.0

(c) *Storage of commercially prepared copra for three months and estimation of loss at intervals.*—The copra was taken at random and stored with other copra. Only moisture and loss of copra were determined:—

Copra.	Originally.	Two months.		Three months.	
	Moisture.	Moisture.	Loss of copra anhydrous	Moisture.	Loss of copra
1	7.4	4.9	5.1	4.6	5.4
2	6.8	5.1	4.0	4.8	3.9
3	9.3	4.8	8.3	4.6	8.7

(d) *Rapid drying of copra on open vatas and removal to storage for three months.*—This experiment was designed to follow as nearly as possible normal working methods in Fiji. Two sacks of copra were dried as rapidly as weather conditions permitted on an open vata and bagged after four days. They were then stored with other copra for three months, being tested once during the interval. The first sample was dried during fair weather and the second sample during bad weather, being rained on on each of the four days:—

COPRA No. 1.

	Drying.		Storage.	
	1st day.	4th day.	47th day.	89th day.
Moisture	45.9	8.8	4.9	4.6
Oil in anhydrous copra	68.7	68.6	69.4	69.3
Free acid in oil (as oleic)	0.2	2.0	6.8	6.4
Loss anhydrous copra .. ..	..	1.1	8.9	9.3

COPRA No. 2.

Moisture	45.7	15.2	5.0	4.8
Oil in anhydrous copra	68.4	68.6	73.0	72.6
Free acid in oil (as oleic)	0.2	3.2	16.4	16.0
Loss anhydrous copra .. ..	..	2.1	20.1	20.8

In all the above experiments allowance must be made for errors. Satisfactory sampling of copra is not easy and no conclusions should be drawn from small discrepancies between the above figures.

Conclusions.—Assuming the tests made to be typical I think the following conclusions may be drawn:—

(1) Copra containing less than 6.0 per cent. moisture does not deteriorate to any great extent when stored in sacks in bulk.

(2) Copra containing over 6.0 per cent. moisture when stored under conditions where it only loses moisture slowly (i.e., in a heap of sacks) deteriorates very considerably. A loss up to 20 per cent. anhydrous copra may occur.

(3) There does not appear to be a simple mathematical relationship between increase in f.f.a. content and loss of copra, although I am of the opinion that the loss of copra is at least equal to the acidity of the oil. In normal experiments the proportion of loss of copra to free fatty acid was as 10 in 7.5.

NOTES ON THE PRICKLY SOLANUM.

By J. D. TOTHILL, D.Sc., Superintendent of Agriculture.

SINCE July, 1928, a considerable correspondence has taken place between the Government as represented by the Department of Agriculture and officials in various countries with a view to ascertaining whether there is any prospect of bringing about by biological means a control or partial control of the prickly bush known botanically as *Solanum torvum* Schwartz. The mere fact that the plant belongs to the potato family which includes many plants of economic importance (c.f. short list at end of this article) in the tropics renders it unlikely that there is in any part of the world an agent destroying this plant to such an extent as to be useful that does not also feed upon at least one plant of economic importance. However, the subject of biological control is one in which the unexpected sometimes happens and consequently it has seemed advisable to proceed at least so far as to explore the possibilities.

The first point to settle was the name of the bush which for many years was known in Fiji as *Solanum tetrandum*. When, however, in 1926 the Ordinance dealing with weeds, known as the Noogoora Burr Ordinance, was extended to include this plant the writer attempted to verify the name but in so doing came to the conclusion that the plant was not *S. tetrandum* at all but a different species *S. torvum* Swartz, and it was therefore gazetted under this name which has since been verified by the Director of Kew Gardens, to whom specimens were sent. This matter of accurate determination is important because insects sometimes exercise a food preference for one only of two or more closely related plants.

With the name settled the next step was to ascertain the distribution of the plant so as to know where to look for insects that might feed upon it. In reply to a letter on this point Dr. Arthur Hill, the Director of the Royal Botanic Gardens, Kew, says:—

The specimen forwarded is a typical example of *Solanum torvum* Schwartz. This species is a common weed in cultivated ground and forest clearings in Tropical Asia, Malaya, Philippines, West Africa, Mexico, West Indies and Tropical South America, but it is difficult and at the present time perhaps impossible to state in which countries it is truly wild.

Solanum torvum is not usually regarded as a noxious weed in these countries, but a form of the species, not identical with the one you send from Fiji, is regarded as noxious in certain parts of Queensland; but there are many varieties of *S. torvum* and some of these should perhaps be considered as distinct species.

Your specimen exactly matches material we have from India and the West Indies, but this does not necessarily imply that India is its native country, though I think it would be well worth while to apply to the Agricultural Research Institute, Department of Agriculture, Pusa, Bihar, India, with regard to insects which feed upon it.

The Keeper of the Arnold Arboretum, Mr. E. H. Wilson, kindly sent the following information in a letter dated 5th August, 1928:—

Swartz in his original description, published in his "Nova Genera & Species Plantarum Seu Prodromus," p. 47, 1783-87, gives the West Indies as the original habitat of this plant. The "Index Kewensis" says that it is cosmopolitan within the tropics. To our knowledge it is found almost everywhere in the tropics of both hemispheres, and it is impossible to say which was its original home. However, in all probability it is a New World species. In this Herbarium we have material collected in—

Am.	Geront.
Cuba	India Assam
Mexico	China Java
Jamaica	Burma
Porto Rico	North Borneo
Grenada	Luzon

In addition I know the plant in Western China, Australia and in tropical Africa.

On July 5th the following letter was sent to Dr. G. A. K. Marshall, C.M.G., the Director of the Imperial Bureau of Entomology, setting out the proposal generally and asking for suggestions:—

This is to advise that the Government has undertaken to make preliminary inquiries as to the possibility of a biological control for the plant *Solanum torvum* Swartz which, presumably was introduced here from India and which now ranks as one of the principal weeds in the Colony. Graziers particularly are disturbed at its rapid progress as, on account of the prickles, the bush is difficult to deal with manually and it is now blocking up some of the best grazing lands in the Colony.

2. The Government is not so far committed to any course of action and replied in the following terms to a question asked in Legislative Council. These terms indicate the official position:—

1. In view of the fact that *Solanum torvum* is closely related to many plants of economic importance it is unlikely but not impossible that insects can be found to feed upon it that would not become injurious to economic plants.

2. Government is aware, however, that the plant in question is a pest of considerable importance and will undertake to make inquiries by correspondence with entomologists in India with a view to obtaining further information.

3. The Superintendent of Agriculture expects to pass through India on leave in about eighteen months' time, and if the results of inquiries are sufficiently encouraging would be prepared to look into the matter and submit recommendations to the Government.

3. I have no set formula but as an initial step have written to Kew for an official determination of the plant which I have provisionally called *Solanum torvum* Swartz.

4. I propose writing to various entomologists in India, Burma and the Federated Malay States asking if they can give me any information on insects that may feed upon the fruit, leaves, stems or roots of this plant and that are not known to attack any plant of economic importance, I am not very hopeful that these inquiries will lead very far for two reasons, one being that there are so many economic plants in, or close to, the genus *Solanum*, and, secondly, because it is doubtful if very much is known anywhere about the insects that attack this plant on account of the fact that in most places it is not of economic importance. I shall greatly appreciate any suggestions you can make in regard to this subject.

Dr. Marshall's reply is here quoted and it will be noted that he assumes, as I had feared, that the problem may be beset with rather more than the usual number of difficulties:—

I must confess that I am in close agreement with the official view which you quote. I certainly think that it would be very risky to attempt the introduction of any insect that attacks *Solanum*, even if in India it is not known to attack anything but a wild plant. The controlling factors in a country like India would probably be non-existent in Fiji, and an introduced species would be likely to behave in a different manner. The probability is that it would become much more abundant, and this would increase the chance of its attacking cultivated *Solanaceae*. It seems to me that the steps you are proposing to take are the best that can be done in the matter, and I cannot think of any further suggestions that are likely to be of use to you.

Letters were then sent to various officials in Ceylon, India, Burma and the Federated Malay States asking for information regarding insects known to feed upon this plant. Replies have now come to hand and for the most part are not encouraging as there seem to be no insects of outstanding importance feeding upon the plant in those countries. This rather suggests that Asia may not have been the original abode of this plant and that it was introduced to Asia from Tropical America.

A few excerpts from this correspondence may be of interest. In Bombay Presidency the Economic Botanist to the Government, Mr. W. Burns, says that the plant is not found wild but that it occurs as a cultivated plant in gardens (letter 9th October, 1928).

Mr. R. C. Broadfoot, Cotton Specialist in the Agricultural Department, writes under date of 29th September that the plant is a common shrub in South India on road-sides and waste places and that it does particularly well where rainfall and humidity are high; the common insects on it are *Epilachna*, a fruit fly, and a fruit borer, all three of which occur on Bringal (*S. Melongena*). The Imperial Entomologist at Pusa, Mr. Bainbrigge Fletcher, says that the plant "is a common wild plant in most parts of India," and suggests "that it would be hazardous to introduce any insects from India into Fiji as they would be likely to attack *Solanum Melongena* (Bringal). The Entomologist for Burma, Mr. C. C. Ghosh, writes that *S. torvum* is a common weed in many places in Burma and says "the only insect I have observed on it, only occasionally, is *Pachyzancla bipunctalis*, the larvae of which web up and feed on the leaves." The Director of Agriculture for Ceylon, Mr. F. A. Stockdale, writes (Sept. 11th) that *S. torvum* "is a common weed in waste places around Kandy, but at the time of special examination by the Entomologist toward the end of August of this year it was not found to be affected with insect pests," and says further, "I am not aware of any insect in this country which could be expected to be of use for the biological control of this plant in Fiji." In a list of insects attacking plants in the potato family in Ceylon drawn up by the Entomologist, Mr. J. C. Hutson, and attached to the above letter the

only ones recorded for *S. torvum* are *Epilachna* sp., which is a leaf-feeding beetle and two plant bugs, *Diphinctus humeralis* and *Aphis gossypii*, the latter of which is an important cotton pest.

The only insect of possible value mentioned in this correspondence occurs in the Federated Malay States. The Entomologist, Mr. G. H. Corbett, says under date of September 28th, "I have caused collections of insects on the plant to be made and have found a promising enemy of the fruit. Specimens of this Microlepidopteron . . . were sent to Dr. G. A. K. Marshall for identification yesterday. I also asked him to supply any further information concerning this insect . . . I feel that the possible reason why this plant is not considered by the Agriculturist to be troublesome is on account of the large percentage of fruits damaged by this moth."

This completes the information obtained so far. As the plant occurs in Tropical America and also in West Africa letters have recently been sent to appropriate officials in various countries situated in those continental areas asking for further information. Replies cannot be anticipated for several months, but when they become available I hope to be in a position to make a further report.

It may be of interest to mention some of the commonly grown plants of economic importance coming in the potato family or *Solanaceae*:—

Chillies—*Capsicum* species (a number of kinds).

Tobacco—*Nicotiana*, *Tabaccum* and *rustica*.

Tomato—*Lycopersicum esculentum*.

Bringai or egg-plant—*Solanum Melongena*.

Cape Gooseberry—*Physalis peruviana*.

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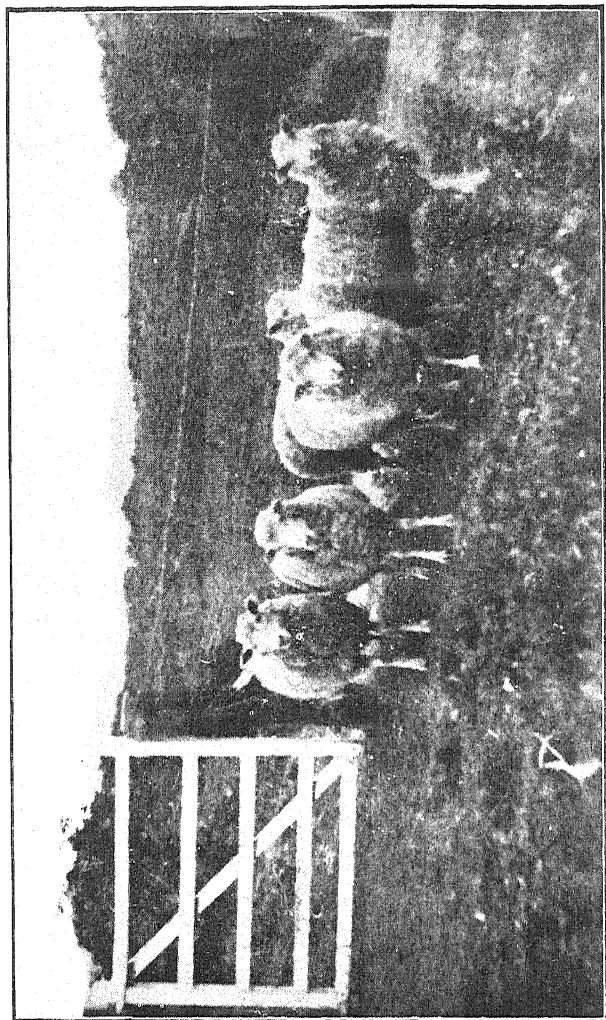
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TYPES OF FIFIAN SHEEP.

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 2.]

FIRST QUARTER, 1929.

[No. 1.]

EDITORIAL.

STAFF CHANGES.

Several changes have taken place in the Staff of the Department since the end of the year.

The Superintendent of Agriculture, Dr. J. D. Tothill, has been promoted to be Director of Agriculture, Uganda.

Mr. W. G. Bennett, B.V.Sc., Government Veterinary Officer, has resigned to take up a position under the South Australian Government.

Miss E. McKearn, Stenographer, has resigned and returned to Australia.

The Assistant Superintendent of Agriculture and Inspector of Produce, Mr. J. Kermack, will act as Superintendent of Agriculture.

Mr. G. A. Wishart will act as Inspector of Produce.

Mr. E. J. Hart has been temporarily transferred from the Treasury to the clerical staff of the Department.

Mr. N. G. J. McNally has been appointed Third Class Clerk.

The Government Entomologist, Mr. H. W. Simmonds has taken over the Editorship of this Journal.

THE SHEEP INDUSTRY IN FIJI.

PAST HISTORY AND RECOMMENDATIONS FOR FUTURE DEVELOPMENT.

By CHAS. R. TURBET, B.V.Sc., Senior Government Veterinary Officer.

INTRODUCTION.

EARLY Fijian literature contains many references to sheep and the subject seems still to be a favourite one. Most of the writers stated that these animals did well, whilst more recent authors give opinions as to why these optimistic forecasts have not been fulfilled. Their general opinion, however, seems to be, that, within certain limits, sheep might be successfully reared in this country, returning a profit to the breeders.

An attempt has been made by the writer to collect as much information as possible concerning these early efforts and place it in proper sequence, so that a study might be made of the factors which have retarded the development of this industry in Fiji, a country which has always been considered suitable for the purpose.

In addition to early references in literature, the author has drawn largely from the experiences of practical breeders in the Colony, supplemented by his own observations during the past six years, as Government Veterinary Officer.

EARLY IMPORTATIONS.

The first importations are reputed to have been made by Dr. Brewer, who was in the United States Consular Service in Fiji, from 1860-1876. Several extensive runs were, some few years afterwards, opened up on the northern shores of Vitilevu and Vanualevu, and on Taveuni, by British subjects from Australia and New Zealand. From these early sheep, samples of wool were sent to the London Exhibition in 1862, some at least of which came from Dr. Brewer's flock, which he ran on the island of Wakaya.

About this date a friend of Seemann wrote: "We find sheep answer well, the wool grows rapidly, the sheep fatten well and the ewes breed rapidly, frequently having three lambs at a birth, so that we can, bye and bye, export wool as well as mutton."

In 1864, according to Ricci, upward of 1,000 sheep were safely landed from Australia, making in all a total of 3,000 then in Fiji. Their importation had been a decided success and generally they were doing well. He augured that, as they were being imported by men of capital, it was not improbable that the interest would largely increase in a few years. This early success and optimism caused Seemann to write: "It was formerly supposed that the climate of Fiji was far too warm for sheep, but that does not now seem to be the case."

Mrs. Smythe, about 1864, quotes from a letter from a Fiji resident: "I told you how we indulged in the rare luxury of a leg of mutton on Xmas Day, and rare I may call it as we have not tasted mutton since. Sheep (Sipi) do well in Fiji, but, as yet, only exist in a very small numbers. Since my last letter a small vessel from Melbourne has gone to the Norfolk Islands to fetch a cargo of sheep, so that in time we hope to hear of Fiji as a wool producing country."

Referring to Makogai, Horne stated that "sheep are bred on the island and several good flocks were seen grazing on the hills." Elsewhere he stated that "stock such as sheep and cattle thrive exceedingly well in Fiji."

None of these early writers make mention of any factor which might militate against success. No pessimistic reports seem to have been made, every reference being couched in glowing terms for a bright future for the industry. Yet, we find, in spite of this optimism, a gradual lessening in the numbers present in the Colony, from the time they reached their first peak in 1888, until to-day, except occasional temporary increases due to fresh importations. Early efforts however must have met with considerable success in order to create the optimistic impression for the future which prevailed in those days.

About 1879, Wilkinson imported a small number and ran them at Bua. This flock seems to have been successfully carried on, increasing to 550 by 1901, but rapidly declined within the next few years. In 1909, however, fresh importations by Mr. H. H. Darcy brought it up to 2,000, after which another decline commenced and, when taken over by Messrs. Edwards and Hall, about 1912, it numbered a little over 1,000. In a short time it was further reduced to about 400, and these were, with the exception of a few, sold. The latter are now in the possession of Mr. H. Edwards at Nabouwalu, who maintains their numbers at about 40, some being sold annually to the butcher at Levuka.

The largest individual flock was that of Mr. A. J. Campbell at Tauarau, which in 1888 consisted of 5,758. It showed a steady decline however from that date and seems to have disappeared about 1903.

In 1887 sheep were grazed in the province of Tailevu to the number of 673. A few years later, however, record of these seems to have disappeared. At the same time a flock of equal dimensions was running at Taveuni, which however had dwindled to 70 in 1900.

A handful were grazed in Macuata province from early times up to 1919, but have now gone, as they have from Navua, where a few were formerly kept; presumably for the supply of mutton, in the days when Navua was a sugar growing district.

Rewa and Suva districts have always had their small quota, chiefly for butchering purposes. They were at one time also fairly successfully grazed at Samabula.

The earliest records available to the writer show that Lau has always maintained a small number, but the same feature is revealed, a decline following each increase due to new importations.

Following Campbell's and Wilkinson's ventures, J. Tyler commenced running sheep at Tavua in the nineties. It is the remains of this flock which is still carried on with success by Messrs. Foulis and Marsh, under the management of Mr. G. C. Foulis at Wainivoce.

In 1908, Mr. K. P. Wright started at Nadroga with a flock of 1,436, maintaining that strength for about eight years. Two years later, however, it was less than half; probably due to sudden sales, before disposing of the property.

When Messrs. Bryce and Howard took over Rasikula, about 1918, there were between 500 and 600 present. Since then this flock has diminished, so that to-day it consists of only a small number grazing about the homestead.

The Government Station at Nadarivatu, when Mr. A. A. Wright was District Commissioner, maintained a flock of 20 ewes, with some rams, raising about ten lambs annually. These served to supply the station with mutton; but they too have now gone.

SHEEP RUNS OF THE PRESENT DAY.

Perhaps the most successful flock now in existence is that of Foulis and Marsh. This is still about 500 strong and is conducted with care. The run is properly fenced, and the animals supplied with licks and mustered regularly for classing inspection, shearing and other operations associated with the industry.

The run is typical of the average class of country along the foothills on the northern and western coast of Vitilevu, being undulating and covered with grass and low scrub, intersected by numerous streams edged with small belts of timber.

Mr. Edward's flock at Bua, as previously stated, is maintained at about 40 head, the wool resulting from his annual clip being regularly sold for good prices.

In 1928, Mr. W. E. Duncan imported from Australia two Dorset horned rams and six ewes, two Suffolk rams, with four ewes and twenty-five Corriedales. His intention is to experiment with those breeds on his Mua Estate on Taveuni. These are now the only sheep on Taveuni and their number amounts to about fifty.

Messrs. Morris, Hedstrom, Limited, also realise the great benefit which would accrue to Fiji if the industry could become well established in the Colony. They have commenced breeding with a trial flock of crossbred Leicester ewes with a Leicester ram, on the island of Kanacea, in the Lau portion of the group.

It will thus be seen that whilst the industry in Fiji has fallen to such an ebb that it can hardly be said to exist, most breeders are of the opinion that the country is suitable for the purpose and that the industry could be made a profitable one.

BREEDS TRIED.

The earlier importations by Wilkinson, were, according to Edwards, Border Leicester. They were well framed, strong healthy animals, well filled in the crutch, and of a good mutton type. The wool was light and inclined to felt badly. The importations of twenty years ago which were added to this flock were largely Romney crosses and Lincoln crosses; also a few half-bred Merino ewes and Romney rams, resulting in a considerable mixture of breeds. Edwards states that the Lincolns did not do as well as the others.

At Wainivoe Estate they were originally Merino, but later became cross-bred, due to the importation of other breeds to endeavour to establish a more suitable type. When Mr. Foulis took over the property he found that the wool was of poor quality and the sheep of an uneven line. He bred the ewes to Merino rams for about three years, but, finding that he was getting a type too close wooled for the climate, imported coarser wooled Romney rams to offset this characteristic. The flock is now of quite fair quality and a more even line as regards size and staple of wool. His last importations were two Border Leicester rams.

The animals on the Rasikula Estate were apparently of mixed breeds, but showed traces of the Border Leicester, and there was also probably some Corriedale present.

The results of the experiments being conducted by Mr. W. E. Duncan at Mua Estate, with Dorset Horn, Suffolk and Corriedales; and those of Messrs. Morris, Hedstrom, Limited, at Kanacea, with crossbred Leicester ewes and pure Leicester rams should be followed with considerable interest by the agricultural and stock-raising fraternity.

TYPE OF COUNTRY.

The type of country which has been considered most suitable for sheep farming in Fiji is that found bordering the Sigatoka Valley and along the foothills of the Western and Northern coasts of Vitilevu from Nadroga to Ra. A similar class of country occurs from Bua stretching along the Northern coast of Vanualevu. It is mostly open, undulating to hilly. In its virgin state it was covered with a dense growth of tall reed-like grass (*Micanthus japonicus*) from 6 to 20 feet high, which is totally unsuited for sheep grazing. It has, however, in most of the more accessible areas, been killed out by heavy stocking with cattle. When treated in this way it is soon replaced by smaller grasses and shrubs. Patches of timber occur in places, whilst a considerable amount is always to be found along the numerous creeks which intersect the country, every small valley having its running stream. Areas of limestones notably in the Sigatoka Valley also occur and these might be considered the choice sites for sheep farming. The dry zone, in spite of its popular description is, however, subject to a wet season, lasting from December to May; with an average rainfall of about 70 inches.

CARRYING CAPACITY OF AVERAGE LAND.

The carrying capacity of the land is variously estimated. Nowhere, however, provided noxious weeds have not taken possession, is more than one acre per sheep required. If kept clear and improved grasses planted a stocking of three to the acre is not too great. From this it will be seen that a flock, about 1,000 strong, might be carried safely on a well-kept 500 acre run.

FODDER PLANTS AND NOXIOUS WEEDS.

When the reed grass (Nagasau) has been destroyed by burning and overstocking it is soon replaced by other herbage and grasses. Unfortunately, however, noxious weeds also come in. In the dry zone Guava is the chief pest of the hills, while *Solanum torvum* is becoming increasingly so on the flats. There are also two types of burr producing plants.

*Lantana sp.** and *Clidemia hirta*, whilst very common in the wet zone, are not yet plentiful in the dry. Of the grasses causing grass seed infestation *Chrysopogon asiculatus* and *Cenchrus echinatus* are the most troublesome, the former being plentiful.

Among the useful fodder grasses are to be found—

Heteropogon contortus.—This is not palatable to sheep when mature, but the young growth, which comes on after burning and subsequent rain, yields a rich pasturage.

Axonopus compressus, the low-lying carpet grass is a good sheep fodder, but not abundant.

Paspalum conjugatum, the luxuriant Thurston grass of the wet zone does not do so well in the dry areas but is found in shaded spots.

Paspalum orbiculare is plentiful, but only the young growth seems to be relished by sheep.

Rhodes grass, *Chloris gayana* and Natal Redtap, *Tricholæna dregeana* have been introduced and the latter is abundant.

Couch grass, *Cynodon dactylon* is becoming more plentiful.

Paspalum dilatatum is also growing in small areas.

Panicum distachyum, called Thurston grass by Greenwood, is probably one of the most useful grasses of the area and is spreading.

The plant *Sida retusa* furnishes some fodder and the *Desmodiums*: *D. triflorum*, *D. heterophyllum* and *D. heterocarpum* are much favoured as feeds.

These three plants replace the temperate clovers and trefoils, which do not thrive in the tropics—

The sensitive plant, *Mimosa pudica* has not extended widely over the dry zone, but is plentiful in the wet. Once sheep become accustomed to it, it is relished and provides good fodder. When first fed off, however, it is apt to cause a dermatitis, affecting the lips and nostrils. This is apparently due to injury from its thorns, followed by infection.

* See note on page 34 of this issue.

Crowfoot grass, *Eleusine indica*, is plentiful and useful.

Kikuyu grass, *Pennisetum clandestinum* has been introduced and promises well.

Other grasses, too numerous to mention, have also been tried with varied results.

Sufficient experimental work has now been done to show the futility of endeavouring to grow in Fiji the vast majority of those grasses, clovers and other fodder plants of temperate regions which have not already become established. For new grasses it will be wise to look to other tropical countries, whilst much more use might be made of useful varieties already established. The improvement of the pasture should be a never ending task. A labour party, according to the size of the property, should be consistently employed cutting out noxious plants, whilst the spread of those fodder plants which have been found to be most useful should be encouraged by the dissemination of seed and by hand planting.

EARLY METHODS ADOPTED.

Early breeders attempted to apply the system of large runs with only occasional musterings to Fiji, such musterings being far too infrequent for local conditions. Only one or two of these breeders fenced properly and little attention seems to have been given to such matters as dipping, regular drenching and licks. In some cases also the rams were not even segregated, leading to irregular lambing with consequent wastage.

CLIMATE.

The climatic conditions prevailing in Fiji are very mild for a tropical country. The rainfall varies from 60 to 80 inches in the different parts of the dry zone. The highest shade temperature seldom exceeds 95° F. and is generally in the eighties in the summer. In winter, noonday heat is about 75° F. and night 55° F. On the most sultry day animals can remain cool by lying in the shade of trees on hill-tops. The ground soon dries after rain if the sun shines. At times, however, long periods of wet weather set in which are not favourable. The wool becomes saturated, not only by the rain itself, but also by the long grass, which, even in dries weather, is saturated with dew every morning. This continual wetting has a bad effect on its quality. Where trees are not already present it is advisable to plant them, many varieties being suitable, the Mango being particularly so.

Periods of three or four months without rain also occur, during which time the pasture rapidly deteriorates, most Fiji fodder plants being water-loving and non-drought resistant.

LABOUR.

There is ample Fijian and Indian labour available for the small requirements of sheep farming. It has been found that Fijians can learn to use both the blades and the hand machine, but are slow workers. That, however, is not a great disadvantage when dealing with small flocks.

LAMBING.

The percentages of increase have been variously quoted by different sheep farmers as from 25 per cent. to 96 per cent. The lambing percentages from the most successful during the last ten years varying from 86 per cent. to 96 per cent. One breeder gives as the reason for the poor lambing on his property that the ewes were much too fat. Whilst this may be true, the writer is of opinion that other causes were probably more important, such as, running the rams with the ewes all the year round, lack of care of ewes in lamb and at lambing, high mortality of lambs in the first few days of their lives from various preventable causes.

WOOL.

One of the author's correspondents, writing about a recently imported lot, was so elated that he wrote: "The new fleece is of very fine quality and texture and from the rate of growth will no doubt require two shearings per year." That second shearing may or may not be necessary, but the report and results obtained from sales of Fiji wool indicate that the climate of Fiji has little if any deleterious effect on it, and that sheep can at least grow a crop which pays. Mr. G. C. Foulis considers that fine and close wooled varieties are not suitable, owing to the heavy rainfall. With close wooled sheep the fleece never becomes properly dry during the rainy season, the yolk gets washed out and the wool loses its "life." The quality of Mr. Foulis' wool is "fair crossbred." His main object, however, is mutton-producing and he aims to produce only such wool as is consistent with the production of good mutton.

Mr. Edwards, writes, that last year's wool sold on 24th August, 1928, in Sydney, brought 1s. 9½d. per lb, and the wool from his flock has always brought good prices. The fleeces are light, the better ones weighing six pounds only.

The sheep from Sigatoka formerly cut fleeces up to 7½ pounds and when sold in the grease in London brought up to 2s. 3d. per pound.

Fijian wool is apt to contain a large amount of vegetable matter. The seeds do not however penetrate deeply, and the great majority germinate, soften and fall out, due to the moisture and heat of the climate. Indeed, sheep have been noticed with grass growing from the wool. The spinning count of Fiji wool of better quality is 56-60.

MUTTON.

An average of 1,577 live sheep and 700 carcasses are imported annually into Fiji for mutton purposes, most of this is consumed by Europeans. The Indian population of between sixty and seventy thousand are however potential heavy mutton consumers, the majority being of those castes which consider the ox sacred and do not eat beef. They now depend mostly on goats to supply their meat ration, but would prefer mutton to goat meat.

The present price for a two-toothed wether runs from 30s. to 40s. With a larger supply this would naturally fall somewhat, but is largely controlled by the cost of importing, from Australia and New Zealand. The average weight of twelve months old wethers on Wainivoe is 42 pounds. The quality of Fiji mutton is reputed to be equal to that of Australia or New Zealand.

DISEASES.

Reports, and the writer's observations, show that sheep in Fiji are remarkably free from serious diseases. There is no liverfluke, whilst nutritional disease is only evident to a small extent. Intestinal parasites (worms) are, however, probably responsible for far more losses than generally supposed. Sheep farmers state that they sometimes find carcasses dead from no apparent cause, such finding not being sufficiently frequent to cause alarm. Intestinal parasites undoubtedly cause most of these deaths, wormy sheep being noticeable in the paddocks at times. Foot-rot is present, but has been noticed more frequently in goats. Possibly these being more numerous attract more attention; hence the impression that they are more frequently and seriously affected than sheep. Blow-fly trouble has not, as yet, assumed the alarming proportion that it does in Australia. It is not a common custom to leave dead animals unburied, or unburned, as it is in some countries badly affected with these pests.

Cancer of the ear occurs. Edwards writes that "about one per cent. of the sheeps' ears become sore, probably caused by sun and rain. I find the simple cure is to clip the end of the affected ear off and this soon heals." This would be very effective as a cure, but in other countries the operation is illegal, as it destroys the identification ear-mark.

Tetanus is reported to have occurred in the Makogai flock many years ago. There are, however, no recent records of this disease so far as sheep are concerned.

CAUSES CITED FOR THE FAILURE OF SHEEP TO BECOME ESTABLISHED.

It has been stated by one breeder that stealing was the worst evil to be contended with, resulting in his case, in the loss of almost the whole of his flock. Other prominent breeders, however, do not mention this as a difficulty. Mr. Foulis of Wainivoco states that "the greatest menace to the industry is the wild dog pest," and on that account he can only run them in the paddocks surrounding the homestead. If wild dogs were exterminated, he considers sheep-breeding would be an easy and profitable proposition. Mr. Edwards also says: "I am perfectly certain that sheep in Fiji would long ago have been a big industry if it had not been for the wild dog question."

It is also claimed that lack of sufficient capital by early sheep experimenters prevented them making the necessary improvements to their runs in the nature of fences, which are essential for the proper handling of sheep.

OTHER CAUSES NOT CITED.

Worm infestation probably causes a greater loss than is recognised as, where the inspection of flocks and pastures is not carried out regularly, sheep which die are not missed until the counting of the flock at the general muster, whilst the dead carcasses would doubtless be destroyed by wild dogs and pigs and thus escape notice.

Little effort seems to have been made to care for the breeding ewes, which, left to themselves in bad weather and with poor grass, must have suffered heavy mortality.

Where wild pigs are numerous they have been known to kill lambs and even ewes, and though loss from that cause has not been generally recognised as serious, it is believed by the writer to be so.

RECOMMENDATIONS.

The following is not intended as a complete treatise on sheep raising, but rather to point out some of the particular requirements for success in Fiji.

Australian methods are not suitable. Fencing difficulties, rapid growth of noxious weeds and, in some places, difficulty of mustering, render large areas impracticable and any attempt on such lines would lead to lack of control, with ultimate failure.

SELECTION OF SITE.

The writer considers that a unit sheep farm in Fiji should consist of no more than 500 acres, running a maximum of 1,000 head.

In selecting his run the prospective farmer should seek undulating country, showing a tendency to produce good grass. In this respect reed land is generally suitable. He should endeavour to avoid areas where guava or

other noxious weeds are abundant. The land should be well watered, have some patches of timber and be reasonably near to an important centre through which his produce could be sent to market.

FENCING ARRANGEMENT.

The laying out of the fencing plan is of the utmost importance, the management of the flock depending upon the amount of capital available for this purpose. It is desirable that the whole run should be fenced and suitably subdivided, whilst if sufficient capital is available, and the nature of the country lends itself to it, the boundary should be dog-proof. This is not easy, owing to the number of difficult streams, also careless people will leave gates open and this is always difficult to avoid. An alternative method, which has the advantage of being cheaper, is to have a central night paddock, surrounded by a dog-proof fence. This should be sufficiently large to prevent the grass being eaten right out and the place becoming a quagmire in wet weather. Water is not essential in this paddock, and it is preferable not to cross streams, which render it difficult to keep the fence dog-proof. It would then be necessary to corral the sheep each evening within this enclosure. This means a little extra labour, but has the advantage of providing a daily check on numbers and condition. It is also advisable to have a second dog-proof fenced lambing paddock, to avoid the necessity for mustering ewes when heavily in lamb. The rest of the run should be subdivided in a radiating manner from the central night paddock. This plan will enable rotation of pastures to be easily maintained.

Fencing is not as expensive as might be anticipated, as wire, stables, iron and steel standards for this purpose are admitted duty free. Posts, Buabua (*Guetterda speciosa*), Vesi (*Afzelia bijuga*), Kukuluva (*Wormia biflora*) and other suitable woods can generally be cut and delivered along fencing line by natives at a low cost. A very useful growing post can be procured in many places and a plantation of these is easily made and quickly grows to post size.

To construct an efficient vermin-proof fence around the night paddock the posts should be 9 feet apart (586 to the mile) for rigidity, but when these are scarce the distance may be increased to 12 feet apart (or 440 to the mile). They should be two feet into the ground and four feet six inches high. A dog-proof fence need not be specially high. The specification should provide for some form of wire netting; the lower edge sunk into the ground with one barbed wire to prevent pigs rooting under it. If ordinary wire netting is used the top should be braced with a plain wire to prevent slackness. The netting should be surmounted with two or more barbwires set not too far apart, to prevent dogs jumping over. For the boundary and subdivision fences the usual six-wire sheep fence with 440 posts to the mile is satisfactory. This latter costs about £80 per mile. The small vermin-proof fence around the night paddock is naturally of a much more expensive design.

THE SELECTION OF A SUITABLE BREED.

It has not been determined which breed, or combination of breeds, is most suitable for Fijian conditions, but as the production of mutton seems to offer the best prospects, efforts should aim to produce as good a fleece as is consistent with this objective. The climate does not seem to suit the Merino, although on Erromango in the New Hebrides, Mr. H. W. Simmonds was informed that pure Merinos are successfully run, the number in 1924 being estimated at 10,000. The whole of the dry area in Fiji is a very similar type of country to Erromango.

Unless prepared to look beyond Australia or New Zealand the choice of breeds is limited, the easily procured kinds being Merinos, Crossbreds and Corriedales. The Crossbred is usually a cross of Merino with Romney Marsh or Border Leicester rams. Of the English breeds these last-mentioned two are the most easily procurable and this fact alone is a good indication of the high quality of both. Most of the flocks of the past have been crossbreds and I doubt whether any one breed has been tried out on its own merits. The Romney Marsh, on account of its robust constitution, general excellency of body and fair quality wool, is deserving of a trial as a pure breed. It is, however, advisable that the number of breeds imported for trial be limited, otherwise there will be degeneration, owing to too much crossing causing lack of character. Finally, in the selection of the breed only a dual purpose animal should be considered, as the prospects of profit are better for that class than one developed solely either for wool or mutton.

THE MAINTENANCE OF THE HEALTH OF THE FLOCK.

As an aid to the maintenance of health, necessary for development of body and growth of wool, licks containing essential mineral elements should be made available at all times. The requirements differ slightly in different localities. It will, however, be found that these licks not only supply deficiencies in the animals' diet, but also have a beneficial action in controlling intestinal parasites (worms).

The prospective sheep farmer should consult the Veterinary Division of the Agricultural Department as to the most suitable one for his particular requirements.

In order to guard against serious losses from the above-mentioned worm infestation, the flock should be regularly drenched with an approved drench.

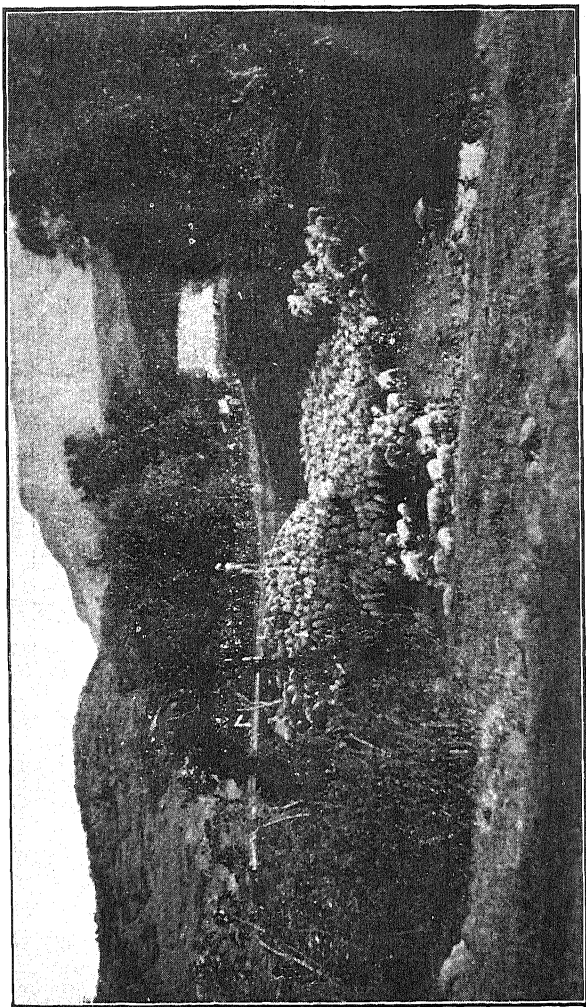
The wild dog pest is most likely to be effectively controlled by a combination of good fencing, conscientious overseering, and a systematic campaign of poisoning, trapping and shooting. In this control work the Government is co-operating.

Except in these details, sheep husbandry in Fiji will not be found to differ in its methods from those employed elsewhere, particularly in those countries where small flocks of dual purpose animals are the rule.

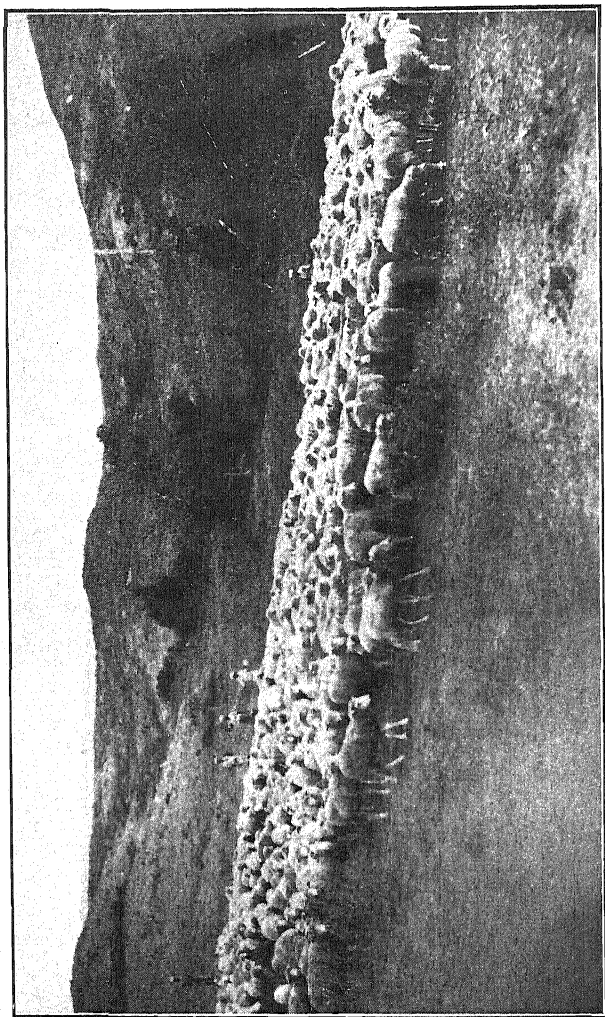
The writer is indebted to Mr. H. Edwards, of Nabouwalu, Bua; Mr. R. P. Little, of Kanacea; Mr. W. E. Duncan, of Suva; Mr. G. C. Foulis, of Wainivoce, Tavua; and the Veterinary Officers of the Department of Agriculture, for assistance in compiling this paper.

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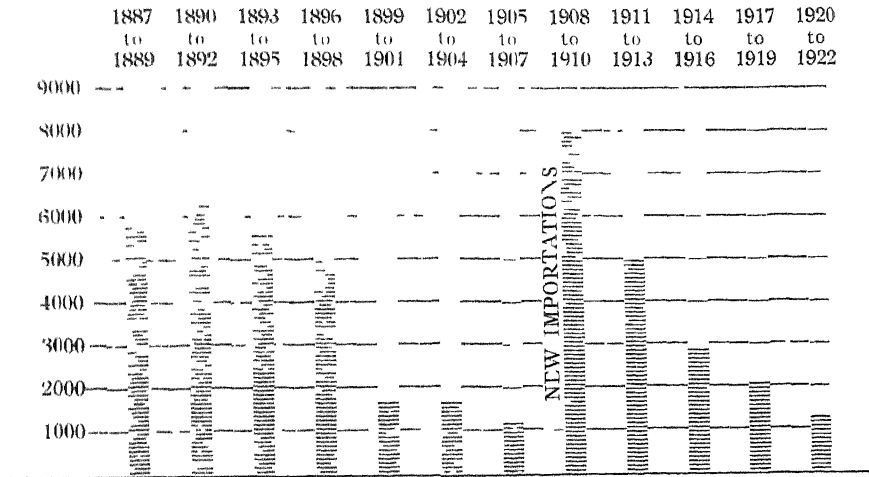


A MOUNTAIN STREAM ON A FUJIAN SHEEP RUN.



MUSTERING IN FIJI, TYPICAL SHEEP COUNTRY.

THE MAXIMUM ANNUAL NUMBERS OF SHEEP IN TRIENNIAL PERIODS FROM 1887 TO 1922



EXCELSA COFFEE.*

By T. B. McCLELLAND.

THE recent hurricane has greatly accentuated a need already felt by the coffee planter long before the storm—that is, the need for new coffee plantings. Owing to the widespread damage to the coffee, extensive new plantings must be made if the plantations are to continue on anything like their former scale.

At the time those plantations were made there was no question of varieties. Only a single variety was available to the planter. To-day he may choose any one of more than a dozen different sorts of coffee. Among these, Excelsa coffee has proved of particular promise for planting under certain conditions, and the experiment station wishes to place the information relating to it before the planters.

This variety was discovered about twenty-five years ago in West Africa. It was soon tested by the Dutch in Java, and presently hundreds of acres there were planted to it. Seeds of Excelsa coffee from Java were planted by the station at Mayaguez in November and December, 1915. Those plantings to-day are showing us something of what we may expect of this variety.

The discoverer of Excelsa coffee, Aug. Chevalier, reported that it is adaptable to a dry climate, mentioning it as found in one locality with a six month dry season and only 1 to 1.5 meters rainfall in the year.

In the wild state it grows in forests below 500 meters altitude and this natural range is presumably the best suited to it. Dr. Cramer of Java says that while it may be grown at more than 4,000 feet it would hardly pay at that altitude and the growth is much slower.

Excelsa may be grown with or without shade, an important adaptability at the present time with the shade trees so extensively damaged or destroyed. At the station it has grown well both under shade and unshaded. In Java it is said to be grown generally under shade, but a lighter shade is preferred for it than that used for other coffees.

Though Excelsa coffee will, of course, grow better in a rich soil, it does not require such, and will flourish in soils unsuited to the best development of Arabian coffee. The root system is notably strong and vigorous, and from the older trunks large roots may be traced far out from the tree.

Chevalier reported Excelsa coffee in the wild state to be a tree from 8 to 15 meters and even sometimes 20 meters high. Grafted trees at this station have attained a height of about 23 feet in 9 years. The growth is very vigorous and the trees attain so large a size that they must be widely spaced. In one of the station plantings the branches of 13-year-old trees spaced 12 feet apart now meet. A closer permanent spacing than 12 × 12 feet would seem inadvisable. However, where the seed supply is abundant and land scarce, a closer planting may be made and alternate trees removed as the growth warrants. In this way the earlier crops will show a higher acre production, but the planter will likely have difficulty in persuading himself to destroy perfectly good trees when they begin to crowd one another.

It is readily seen that the picking of the crop from trees so tall as Excelsa is not an easy matter when the planting is on a steep slope. Even though most of the trees at the station have been topped at 12 feet, ladders have had to be used and on steep slopes that is difficult. It is quite probable that on steep slopes the trees should be kept at such a height as to make ladders unnecessary in harvesting the crop, even though the lower heading-back of

* Reprinted from the *Agricultural Notes*, No. 45 of December, 1928, published by Porto Rico Agricultural Experiment Station, Mayaguez.

the tree should result in a somewhat reduced production. On more nearly level land where ladders can be used the trees should not be allowed to grow above 12 feet in height. If the tree is allowed to attain this height before being topped, there will have been a loss of irreplaceable lower primary branches. The initial topping should be when the tree is small and still retains the first primary laterals. When four pairs of laterals have developed is a good time to top. Growth will then be forced into the laterals and they will develop into large branches. When they have become strong and well-developed, an upright branch may be allowed to grow from the trunk and carry the growth up to the desired height.

The leaves of Excelsa coffee are of much stiffer, heavier texture than those of the Arabian coffee and are larger, measuring 8 to 12 inches in length and 4 to 6 inches in breadth. They are much less subject to leaf miner injury. Although the leaf miner enters, it makes little headway. For localities where the ravages of this pest are excessive, the planting of Excelsa coffee rather than Arabian is recommended.

The crop begins to ripen in December or January and continues into the following summer, thus ripening in the months when the Arabian coffee is not being picked and when labour is most readily available on the coffee plantations as constituted to-day. This variety is much less liable to loss from over-ripeness than is the Arabian coffee, and in consequence there may be longer intervals between collections. The ripening season coincides with the drier weather, which favours the picking of the crop. Since the cherries are quite immature and many of them still small in the hurricane season, the probability of wind damage to the crop is less than in the case of the Arabian coffee, provided, of course, that the tree itself is not broken, blown over, or killed.

The pulp is firmer and less juicy than that of Arabian coffee. It is thinner, however, than that of some other members of the Liberian group to which Excelsa belongs, and the machinery ordinarily used in pulping Arabian coffee may be used for Excelsa.

The cherries on the average are smaller than those of the Porto Rican coffee but there is little difference between the two in bean weight. The loss in weight on removal of parchment is about 26 per cent. for Excelsa in contrast to 17 per cent. for Porto Rican. While an almud of cherries of Porto Rican coffee is generally considered as the equivalent of 5 pounds of coffee beans after removal of parchment, an almud of Excelsa gives but 4 pounds of cleaned coffee. This makes the picking of Excelsa relatively more costly. The total reduction in weight from cherry to marketable bean in samples prepared at the station was in the ratio of 7.2 to 1. That is, for one pound of coffee as marketed, 7.2 pounds of coffee cherries were picked.

The bean is of a totally different appearance from the Porto Rican and for marketing purposes the two should not be mixed. The silver skin is of a pale brownish colour and the bean is straw-coloured or yellow. A considerable portion of the silver skin adheres to the beans, giving them a rough and uneven appearance, unless they are rapidly dried by artificial heat. A fragment of the parchment is likely to be held in the deep sutures, which also detracts from the appearance.

The quality of the beverage prepared from Excelsa coffee is good and would be acceptable locally. In marketing this coffee could not be sold as Porto Rican, to which it is much inferior in appearance, but would be classed presumably as Liberian, to which it is more closely related.

The rate of production of Excelsa coffee in Porto Rico to date is shown in the accompanying table. Each of the four groups contains from 10 to 40 trees, but the production is raised in the table to an acre basis calculated on the area planted and a reduction rate of 5 liters of cherries to one pound of coffee after drying and the removal of the parchment. Each group except D, the smallest, has lost some trees. The production is accordingly smaller than had the stand been complete, but this is a normal condition and such as ordinarily might be expected on the plantation. Groups A and B are the oldest, and group A is the largest as well, originally set with 40 trees and now containing 37. In both groups the trees are spaced 12×12 feet. In A the trees were topped at 12 feet when a little less than 7 years old, in B the growth has been unchecked. In groups C and D the trees are spaced 10×10 feet. At six years the trees in C were topped at 12 feet and those in D at 6 feet, this operation in the latter group entailing some loss of crop. The soil in which these trees are growing is certainly not superior in fertility to that of the average coffee plantation, and some of it would be considered very poor. No fertiliser has been applied to it.

ANNUAL RATE OF PRODUCTION PER ACRE IN POUNDS OF
COFFEE, PARCHMENT REMOVED.

Age of Trees.	Group A.	Group B.	Group C.	Group D.
Years.	lb	lb	lb	lb
5	57	33	—	—
6	275	168	64	41
7	238	187	55	139
8	652	417	209	—
9	204	814	211	—
10	970	28	348	—
11	585	63	—	—
12	946	895	—	—

The table shows that production began at 5 or 6 years from planting the seed, but that no large production was had under 8 years. In group A the average annual production from the 8th to the 12th year was 671 pounds, a very satisfactory yield. In the smaller group B for the same period this was 443 pounds. In group C the production has been less satisfactory, which may be ascribed, at least in part, to late topping and too heavy shading.

In summing up, Excelsa coffee possesses certain advantages and certain disadvantages in comparison with the Arabian coffee grown locally. It is less exacting in its shade requirements and may even be grown without shade. Its adaptability to a dry climate renders it less subject to injury from a protracted dry season. The vigorous root development and robust tree growth even on poor soils indicate this to be a promising variety for planting in many localities less suited to the more exacting Arabian varieties. Its resistance to the leaf miner is an attribute of paramount importance in some sections. The yield is comparatively high and the crop, ripening as it does in the drier months of the year, is much less liable to loss through wind or rain. The cup quality is good.

Against these good points, there are several less favourable characteristics. Excelsa is late in reaching full production. The reduction in weight on curing is high, an almud giving 4 instead of 5 pounds of cleaned coffee. On account of the less attractive appearance and the smaller established demand for coffee of this type, the product would be less readily marketable at a good figure.

TOMATO GROWING IN THE TROPICS.*

A FEW HINTS.

By J. M. CALWAY.

ONE of the difficulties that tomato growers in Fiji have had to contend with in the past has been the absence of a local market to absorb that portion of their fruit which matured between shipments, resulting in the loss of an appreciable percentage. Now, however, that a start has been made in the canning industry it is possible that someone may become interested in using the tomato for this purpose. In which case, if the surplus could be canned at prices that would cover expenses, tomato growing for export should offer encouraging prospects, either as a side line or, whilst waiting for more permanent crops to mature.

Fiji is fortunate in possessing a near overseas market, demanding this fruit and being itself unable to economically supply it during several months of the year.

Few plants crop so heavily in so short a space of time, whilst, when cultivated on scientific lines and with the advantage of a tropical climate, the capital outlay is also small. From ten to fifteen tons per acre may be harvested, commencing to mature two months after planting, whilst planting can be carried out during eight months of the year.

Tropical conditions do not, however, allow the methods practised in temperate regions to be followed exactly, so that the following notes may prove useful to those who would like to try this fruit commercially.

Almost any soil in Fiji will be found suitable, except very loose and sandy types, providing that a fair amount of humus (decaying vegetation) has been worked into it, whilst a dusting of ashes, and a little blood and bone manure, where the plants are set, helps. Well rotted horse, or cow manure is equally good. It is not advantageous to use nitrates, which accelerate the growth of foliage at the expense of fruit, and without which the plant grows, in the tropics, at an abnormal rate.

Diseases can be dealt with in the same way as in temperate zones. Fiji is not, however, at present seriously troubled in that way, the most important being "wilt." This can be minimised by strict attention to "mulching" and seed selection, whilst it also helps if seed is selected from those of your own plants which have shown natural resistance to this trouble.

SEED-SOWING.

Sowing in the open is not recommended, the chance of raising a good batch of seedlings being very remote. A heavy rainfall flattens them when small, or a hot sun following "cooks" their roots, whilst in the earlier stage, the seeds may be battered to varying depths, defeating the object of uniform development.

Apart from these risks, even in the event of a good batch being raised, the plant is so tender as a seedling that it does not recuperate easily from open bed transplanting.

Good seed-pans can be made from benzine tins, or cases, and need only be two or three inches deep.

The soil should be fine enough to go through a quarter inch sifter, but it should *not* be rich in plant-food. When placed in the seed-pan it should be lightly patted with a board so that a fair level may be had, to ensure uniformity of growth from the start. Water lightly and distribute the seeds evenly over the entire surface and then cover lightly with fine soil,

* Through the courtesy of Mr. J. M. Calway, who is the authority for this article.

using only sufficient to just hide them. Press lightly again with the board, so that the seeds are firmly embedded in the moist soil underneath. Keep the seed-pans under cover and away from wind, in order that repeated watering may be avoided.

SEEDLINGS.

The seedlings require an even distribution of light otherwise they will neither grow sturdily nor upright. Thus, if the seed-pans are placed against a wall, the young plants will quickly stretch towards the light, and soon become spindly, the same effect being produced if the overhead cover is low and excludes the light. This can be rectified by turning the seed-pans daily.

When the second pair of leaves are developed the seedlings may be "pricked off."

"PRICKING OFF."

It may seem that moving the seedlings from one tin to another is a needless waste of time and labour, but such is far from the case. The spacing of the young plants in a good rich compost for a few weeks, before finally planting out, is very essential in the tropics, the success of the crop largely depending upon how well this operation is carried out.

A compost of fine loam, containing from 20 per cent. to 25 per cent. of humus, a little blood and bone manure and a dusting of ashes, should be well mixed before being put through a quarter inch sifter. Boxes or tins similar to those used for seed sowing, but with suitable drainage holes made in the bottom, are filled with the compost. Press the surface firmly with the board and give a little water.

Use a small round stick, like a pencil, not too sharply pointed, for levering the seedlings, after watering, out of the seed-pans, and also for making the shallow holes in the compost to receive them. Put the seedlings two inches apart in the new container.

The half of a benzine tin cut to suit will thus carry two dozen plants comfortably (6×4).

To protect the plants until they are strong enough for the field a light frame should be erected. This should stand clear of any outbuildings or trees, so that there will be an even diffusion of light. The roof should be made to carry "scrim" or light sacking only. This should slope away from the ridge to either side at an angle of 45° . The "scrim" is tacked on to the ridge, but fixed at the bottom, so that it can be rolled up or let down at will. A thin piece of lathing or bamboo, fixed along the bottom, will act as a weight to keep it tight when down and, as a roller when necessary to put it up.

The tins of plants may be placed on boards and trestles of an improvised nature to keep them away from ground pests. A frame eight feet wide, and long enough to carry seven yards of scrim on either side, will protect sufficient plants to fill over an acre of ground, and it can be refilled every twenty-five days during the season. The blinds are necessary to exclude the mid-day sun and to break the force of heavy rain while the plants are still small. They are lowered at night, but from early morning, until the sun is too hot and from early afternoon until sunset, every advantage should be taken of the light, except during heavy rain. As the plants grow stronger the overhead protection should be gradually removed.

The advantages gained by the use of the frame and pricking off are as follows:—

1. Protection to the plants in the early stages.
2. "Checking" them by the "pricking off" process.

3. Exclusion from the effects of abnormal sun, and rain conditions.
4. Premature flowering is avoided. Plants introduced to the tropics from the temperate zones if cultivated from seeds in the open ground are likely to be affected with "premature flowering". The abnormal condition "force" the plants to bloom and seed before they have had time to grow sufficiently strong. This causes them to dry off from exhaustion when only a few inches high, leaving only miserable specimens of fruit that cannot be used.
5. The protected plants, in good compost, make better progress than they would in the open and being concentrated, the number that would otherwise cover an acre can be attended to in a few minutes each day.
6. Losses from subsequent transplanting are avoided, as the tins can be taken out to the actual planting spot before being disturbed. It will then be found that each plant will carry with it a solid block of the compost when taken out of the tin, sufficient in food value to enable it to establish itself.

PLANTING OUT.

Planting is best done on cloudy weather or, if this is not possible, during the late afternoon.

If the tins have been well watered, before the plants are disturbed, it does not matter much if the land is fairly dry.

Place the plants four feet apart, leaving at least four feet between the rows, to allow a passage for tying and thinning.

After planting, the most important item, and one that must not be neglected, is the application of a mulch. This may consist of grass clipping, dried grass, leaves or any vegetable matter, placed round the stem of each plant one inch deep, and covering at least one square foot of ground surface. This will be found to prevent overheating of the soil, thus obviating "wilt" and in addition conserving moisture. It is also labour saving, making watering seldom necessary. If the plants are not mulched, constant watering does not prevent wilting, but rather tends to promote the trouble.

The mulch must not be piled against the stem, as it induces stem rooting above the ground, which is most undesirable. If the plants are put in firmly and the soil levelled off, the mulch only requires to be spread on the surface.

STAKING AND TYING.

Stakes six feet long should be driven into the ground to the depth of a foot, at a distance of three or four inches from the stem of each plant. This should be done as soon as possible after planting, to prevent injury to the roots.

Coarse binder twine is the most suitable material for tying purposes, the first tying taking place when the plants are about eighteen inches high. This should be repeated at eighteen inch intervals as the plant progresses.

The twine is twisted twice round the stake and is only used to pull the stems of the plant in, not to completely encircle it, which would tend to strangle growth. Care should be taken when tying not to confine any of the young fruit between the stakes and the stem; such fruit becomes cramped as it matures.

THE ONE-STEM SYSTEM.

There is only one way to grow good table or export fruit, that is by the "one-stem method." The bush system, generally practised, has nothing

to recommend it, and for commercial purposes should be prohibited. The plants grow, spread over the ground, where they cannot be nourished, or watered, without the fruit being splashed. Heavy rains batter the latter against the ground, soiling it, whilst many of the flowers produced have little chance of setting in the tangled mass, which is rarely dry and gets little sun. Only the upper portion under these conditions, is productive, and the fruit produced is generally irregular in size and shape, and may range in weight from an ounce to a pound, putting grading economically out of the question. Contrary to local opinion, such big fruit is no advantage in the oversea market.

The "one-stem system" keeps the fruit away from the ground, so that both flowers and fruit get the maximum of sunlight, and the plant is only called upon to produce what it can support. The crop is of a more uniform size and can be graded without difficulty. Starting from the first truss, about eighteen inches from the ground, each truss or bunch matures in turn up the whole length of the stem and it is a simple matter to calculate what quantity will be available for shipment.

From the beginning all laterals (side shoots) must be removed. This operation has to be attended to continually, as they grow quickly absorbing much of the vitality of the plant. By rubbing them off as soon as they appear, a large area can be gone over in a very short time; whilst the strength of the plant is not taxed to promote growth that will be later removed.

GRADING AND PACKING.

Tomatoes for export can be harvested as soon as the creamy spot shows through the green skin. They should be picked into large trays in order to avoid bruising.

The standard size for marketing is a little smaller than a tennis ball. The market demands 3 or 4 to the pound. Larger fruit is not a marketable proposition.

There need not be more than three grades—

1. A little above standard size.
2. Standard size.
3. A shade smaller than standard size.

Great care should be taken in this matter. It will be found that the "one-stem plant" produces a crop that can be absorbed by three grades without difficulty, but under the "bush system" grading is a practical impossibility, not only because the fruit varies tremendously in size, but it is often unshapely.

Each layer in a case should be protected from its neighbour by a sheet of white packing paper in order to minimise bruising, and retard ripening. One over-ripe tomato in a case can be more deadly there than it ever was at a election meeting.

To achieve success the main points to be observed are—

- (1) Protect and bring forward the young plants under cover for as long a period as is consistent with field planting.
 - (2) Pay strict attention to mulching *after* planting out.
 - (3) Work on the single-stem plan.
 - (4) Look upon packing and grading not merely as a means of disposal, but as the most essential part of the whole business.
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TAILEVU DAIRY SCHEME.

A HISTORY OF THE TAILEVU DAIRY SCHEME TOGETHER WITH
A REPORT ON THE PRESENT POSITION OF THE SCHEME
AND RECOMMENDATIONS FOR ITS FUTURE MANAGEMENT.

By J. D. TOTHILL, D.Sc., Superintendent of Agriculture.

INTRODUCTION.

WHEN the Tailevu Dairy Scheme was first agreed to by the people of this Colony one of the avowed purposes was to establish a new industry in the Colony. As a direct result of the Scheme there are now three butter factories in the Colony and the value of the new industry is shown in the following figures of production starting from the day on which the first pound of factory butter was made at Korovou:—

<i>Year.</i>	<i>Pounds of Butter.</i>	
1920	—
1921	13,104
1922	23,785
1923	59,219
1924	143,219
1925	168,844
1926	247,727
1927	302,513
1928	313,655

1,272,066 valued at 1s. 9d. lb = £111,305.

The question of land settlement for returned soldiers was first brought up in Legislative Council by the then Governor, Sir Cecil H. Rodwell, in the form of a Message laid on the Table on 1st July, 1919 (C.P. No. 37 of 1919). As annexures to the Message were schemes of land settlement prepared by the Lands Department one of which was to make lands in various parts of the Colony available to returned soldiers on very easy terms and another of which was to arrange for six selected settlers to grow coffee on the Waimaro.

After a discussion (p. 148, 1919 *Hansard*) Council passed the motion:—

“That the Council approve of the principle of assisting Returned Sailors and Soldiers on the lines proposed provided that the expenditure involved from Public Funds does not exceed £6,000 and recommend that a Special Committee be appointed by the Governor to consider the details of the Scheme referred to in the Message and any other questions affecting the welfare of Returned Sailors and Soldiers.”

THE CROMPTON COMMITTEE.

The members of this Committee were—

The Hon. R. Crompton, C.B.E. (Chairman).
The Hon. Acting Attorney-General.
Superintendent of Agriculture.
District Commissioner, Rewa.
Mr. E. Duncan.

And their report became Council Paper No. 2 laid on the Table on 7th May, 1920.

This report is a very complete document and shows that the Committee went into the matter with great care and in elaborate detail. The Committee advised against the land settlement schemes referred to in the above

Message and recommended unanimously that the Government should endeavour to establish a Dairy Industry. Detailed proposals for establishing this industry at Tailevu constituted the main part of the report.

The scheme proposed was the starting point for the one now in operation but a few points of difference may be noted:—

- (a) It was estimated to cost £52,080 whereas it has actually cost approximately double this sum.
- (b) It was proposed that the factory part of the scheme should, as soon as the factory was built, be run as a Private Limited Liability Company "with a nominal capital of say, £10,000 divided into 10,000 shares of £1 each" and that each tenant be compelled to take four shares for each heifer supplied to him, the shares to be paid for at the rate of 2s. 6d. on application, 2s. 6d. on allotment and the balance to be deducted from the monthly cream cheque at a rate not to exceed one penny per lb of butter fat.
- (c) It was proposed that £2,000 be devoted to sending the prospective tenants to the Hawkesbury Agricultural College or other suitable place for six months to receive tuition in dairying, whereas in the scheme as adopted provision was made instead for a qualified dairyman to oversee the scheme and provide the instruction.

MESSAGE NO. 3 OF 1920.

In Message No. 3 of 1920 the Governor invited the attention of Council to the report and suggested that without committing itself to the details of the scheme Council should "approve generally of the establishment of a dairy industry on the lines recommended in the report; that a sum of £2,300 (a clerical error for £3,300) be voted for the acquisition of the areas in the Tailevu district named in the report; that a sum of £2,000 for the proposed training be voted and that Council approve in principle of providing the funds estimated at £17,000 per annum for three years."

The Hon. R. Crompton moved for the adoption of the Message, the motion being seconded by the Superintendent of Agriculture. In the ensuing debate both sides of Council supported the proposals very fully, the only criticisms offered coming from the Hon. R. Harricks and the Hon. F. C. Clapcott (pp. 54-55 *Hansard* 1920) who thought that it would be better to substitute the acquisition of a dairy expert in Fiji for the proposed training at an agricultural college of the individual tenants. The Hon. F. C. Clapcott also said "I am going to support the motion but at the same time would point out that so far as the returned men are concerned it is possible that the scheme will be a failure for them because we are asking these men to do the hardest work there is. We are asking them to experiment."

With these minor criticisms it was unanimously agreed "That this Council approves of the Governor's Message No. 3 of 1920 and authorises the expenditure."

PROGRESS UNDER THE FIRST COMMITTEE OF MANAGEMENT.

A Committee of Management was then set up with the Superintendent of Agriculture as Chairman and the scheme was proceeded with. Mr. P. Waller was appointed by the Committee as Dairy Instructor and his first report, dated 9th December, 1920, was printed as Council Paper No. 2 of 1921. This report shows that 140 acres had been cleared by that date and that matters generally were moving forward.

One of the reasons put forward for selecting Tailevu lands for the scheme was that as every farm had access to navigable waters it would be unneces-

sary to incur heavy expenditure for road construction. The waters were considered by Mr. Waller to be unnavigable and in this first report he says: "I must therefore press for the construction of the roads as a very urgent matter." In the same paper Mr. Knowles, in a report to the Hon. the Colonial Secretary, states that arrangements for the roads were being made accordingly. Mr. Waller also advised that a twin screw launch being built for the scheme would be excessively expensive to operate but the contract had been let and the launch was completed.

MESSAGE NO. 1 OF 1921.

In Message No. 1 of 1921 (C.P. 5 of 1921) the Governor, Sir Cecil Rodwell, recommended, on advice of the Committee of Management, that costs of instruction, imported stock and administration, amounting to £4,050 should be met from General Revenue and be considered as non-recoverable from the tenants. The motion for the adoption of this Message was agreed to on 13th April, 1921 (p. 51 *Hansard*) and an interesting point brought out in the debate was that it was the intention of the Committee of Management to use the imported bulls for the establishment of a stud farm for the benefit of the whole Colony.

Provision was also made for the importation of machinery for the factory on a duty free basis (p. 38, 1921 *Hansard*).

THE HON. F. E. RIEMENSCHNEIDER BECOMES CHAIRMAN OF THE COMMITTEE OF MANAGEMENT.

When Mr. Knowles was transferred to the Gold Coast the Hon. F. E. Riemenschneider became Chairman of the Committee of Management and a report, under date of 29th October, 1921, was printed as Council Paper No. 56 of that year. A balance sheet attached to this report shows that the sum of £48,364 6s. had now been expended, the factory was ready for handing over, but there was still an insufficient supply of cream to make factory operation possible. The report also shows that the difficulty of accumulating dairy cows had been apparently partially solved by the purchase of 400 Ayrshire cows from Messrs. Tarte Bros.

SCHEME ARRIVES AT A CRITICAL STAGE.

The scheme had now arrived at a critical stage. The funds originally contemplated had been spent. The factory was complete but pastures were not ready and insufficient cows were available to produce sufficient cream to enable the wheels of the factory to turn. Moreover, the road from farms to factory was not complete and without a gravel surface was of little use for the transport of cream. Finally, when the cows began to arrive from Taveuni it was found that they were unsuited to the needs of the scheme.

THE SCOTT COMMISSION OF INQUIRY.

A Commission of inquiry was therefore appointed by the Acting Governor on the 25th of January, 1922, to inquire into the management and progress of the scheme, the Commissioners appointed being the Hon. H. M. Scott, K.C. (Chairman), J. J. Barker and G. C. Foulis.

The Commission found (Council Paper 24 of 1922) that the cattle purchased from Tarte Bros. were wholly unsuitable for dairy purposes and recommended cancelling the contract on the best terms possible. It held that all members of the Committee of Management at the time of the purchase were responsible for an ill-advised transaction and recommended that the Committee be disbanded. It reported that the progress of the scheme generally could not be regarded as satisfactory.

A series of recommendations were made involving a very large further estimated expenditure of £34,800 7s. 11d. of which amount £8,130 was in hand under the control of the Committee of Management. More than half of this was for further advances to settlers; £2,000 was for gravelling the road, £2,000 was to finance a demonstration farm at Tailevu, £2,100 was for a manager's salary for two years and for a factory loss for eighteen months.

As to control, although the original scheme contemplated handing the factory over to a Limited Liability Company with the producers as compulsory shareholders according to their quota of cows, the Commission evidently considered that the time was not ripe for such a step and recommended placing control in the hands of a salaried manager who would reside at Tailevu and be responsible for expenditure directly to the Government.

DEBATE ON THE SCOTT COMMISSION REPORT.

The subject matter of this report was discussed at length in Legislative Council on 8th June, 1922 (pp. 60-68 *Hansard*) and the seriousness of the position is reflected in the debate. Government undertook to look into the question of the advisability of removing the scheme to Rewa or to Navua where the difficulty of transport to Suva would be overcome. The conclusions of the Commissioner's Report were finally agreed to but not the recommendations involving further heavy expenditure. The motion agreed to, which was moved by the Hon. the Colonial Secretary, the late Mr. T. E. Fell, C.M.G., and seconded by the Colonial Treasurer, Mr. H. H. Rushton, who had recently arrived in the Colony, reads as follows:—

"I move: By direction of the Governor that this Council agrees with the conclusions expressed by the Commission in paragraph 49 of the report and approves of the expenditure from Public Funds of a sum of £4,000 in order to carry on the Tailevu Dairy Scheme for a period of three months within which time the report of an expert may be obtained as to the best means to be adopted to place the scheme on a sound permanent footing and to render it eventually self-supporting."

Mr. George M. Valentine, Dairy Instructor for the New Zealand Government, was then invited to come to the Colony and report upon the scheme. In the meantime, Tailevu matters improved sufficiently to enable the Governor, Sir Cecil Rodwell, to say in his address to Council on 7th December, 1922 (Council Paper 50 of 1922) "The prospects of the Tailevu Dairy Scheme are much more satisfactory than they were six months ago. It may be too early to speak of the scheme as an assured success, and money has been wasted which can never be recovered, but I think it may now be said that the worst corner has been turned."

MR. VALENTINE'S REPORT.

Mr. Valentine's Report was tabled on 15th December (Council Paper 74 of 1922). In view of wide experience in dairying matters his report is of particular interest and largely on his advice Government decided not to abandon the scheme. He says: "I am convinced that there are large areas of good land on which dairying can be successfully carried on, not only at Tailevu but wherever a sufficient area is available." He thought that Rewa would have been a better place to start a factory than Tailevu but that, having been started at Tailevu, the scheme should be continued there. He stressed the importance of connecting the scheme by road to Suva. He was opposed to the Taveuni cattle purchase and also to that of the twin screw launch. In the report it was pointed out that one of the unforeseen

expenses had been the high cost of bringing bush land under grass and that a mistake had been made in felling so much bush in the first instance, that weeds came in before the land could be grassed; experience had shown that it paid to reclaim the bush land slowly. However, in spite of all the mistakes some of which were due to mismanagement and some to inexperience, Mr. Valentine was of opinion that "the scheme has now reached the stage where its success is assured provided the tenants put their best work into it." A reassuring feature in the report was the result of milk tests which showed that "the average fat content of the milk samples tested at the factory was 3.79 per cent. practically the same as New Zealand at the time of lactation." Of those tested "the best herd averaged 636 lb of milk containing 25.35 lb of fat in 30 days."

As to future management, the report says: "the formation of a Co-operative Dairy Company to take over the factory will be necessary as time goes on and "probably some time will elapse before the tenants are in a position to form such a company but until the company is formed I would suggest no alteration in the present system of management Mr. Rushton, the Treasurer, has controlled and directed the financial and economic side of the scheme with unusual ability and foresight." The "present" control referred to was direct Government control through the Treasurer with a resident manager at Tailevu, Mr. Hamilton, being responsible directly to the Treasurer.

PURCHASE OF VUNA CATTLE COMPLETED.

Mention has been made several times of the purchase of 400 cattle from Tarte Bros. at £12 per head. In view of the unfavourable report on this transaction by the Commission an opportunity was given Messrs. Tarte Bros. to withdraw from the contract. They did not, however, take advantage of this opportunity and the balance of the cattle was taken over in December, 1922, after being tested for tuberculosis. In a report under date of 24th January, 1923 (Council Paper No. 4), Mr. W. Hamilton says of these cattle: "It is difficult to say what the value of a selection of 400 at the date of purchase was, but I can definitely say that, as a dairy farmer, I would not have purchased 400 of such a herd for myself at any price although it is quite possible that at that date when prices were running high, a selection of the 100 best might have been worth £12 each." The Government Veterinary Officer, Mr. McKenzie told the Treasurer at this time that in his opinion the value ranged from £5 to £6 each plus whatever increased value the passing of the tuberculosis test might be deemed to give them.

A PROTECTIVE DUTY IMPOSED ON BUTTER.

In December, 1922, a protective duty of 2d. per pound was imposed for a limited period of six months. At the close of the following year assistance was given to the industry by the passage of a Bill (*Hansard* p. 178) to amend the Customs Duties Ordinance 1921 so as to provide a duty of 4d. per pound on butter manufactured in the British Empire, part of this to be regarded as a protective duty for the nursing industry. In the debate on the motion it is stated that while astonishing progress had been made at Tailevu it had been necessary to pay 1s. 6d. per pound for standard grade butter fat in order to keep the settlers going. Many of the settlers had neither sufficient grass nor cows although all but two had become self-supporting. It is clear from this debate that the factory wheels were now turning, butter was being sold readily in Suva, and progress had been made.

THE DAIRY INDUSTRY ADVANCED BY THE ERECTION OF TWO FACTORIES AT REWA AND NAVUA.

On 21st November, 1924, the Acting Governor, the late Mr. T. E. Fell, C.M.G., said in an address to the Legislative Council (Council Paper No. 45 of 1924): "The dairy industry continues to progress; companies have been formed at Rewa and Navua and a new factory on the Rewa has been opened during the year."

ANOTHER DIFFICULT PERIOD AT TAILEVU.

In the meantime a Committee had been appointed by the Governor, Sir Cecil Rodwell, "for the purpose of considering the future of the Tailevu Dairy Scheme."

This was appointed as a result of a motion by the Hon. Alport Barker, Member for the Southern Division, who had in company with the two other Country Members spent two days examining conditions at Tailevu. The debate on this motion (pp. 90-96 *Hansard*, 1924) gives a picture of Tailevu that is steeped in gloom. Amongst other things, the Hon. Alport Barker says of the original report on which the scheme was based that he can "only characterise the framing of that report as so mistaken and ill-advised as in my opinion to be criminal." Of the settlers he says: "I foresee the time when they will give up in despair and gradually one by one drift from the scheme, killed by the Hindenburg line of curse." The solution is to transfer to the Rewa or to the Sigatoka. "I strongly favour the idea of transfer as the only salvation of the men" and later he says: "I was always against Tailevu as a site for the scheme and was always in favour of Rewa." The Hon. P. W. Faddy said: "I cannot see any one bright spot appearing in the whole of the scheme." He emphasised the lack of sufficient flat land on each farm and suggested a rearrangement of the farms or transfer as the solution. The Hon. A. H. Roberts said: "that something has got to be done for the men, either to transfer them to another district or to extend the flat lands as the men themselves perhaps would prefer." It is interesting to note that in accepting the motion the Governor, Sir Cecil Rodwell, said: "It is one of the most doleful stories I have ever heard and it is very difficult for me to understand with what extraordinary rapidity the position at Tailevu must have changed. It is only a few months ago that one of the best New Zealand experts, Mr. Valentine, reported most favourably on the prospects of the settlement," and at the close of his speech said: "I still believe in spite of the doleful picture that has been drawn that the dairy industry in this Colony will prove to be a success."

WORK OF THE RUSHTON SPECIAL COMMITTEE.

The Special Committee appointed "for the purpose of considering the future of the Tailevu Dairy Scheme" consisted of the Hon. H. H. Rushton (Chairman), the Hon. Alport Barker, R. Crompton, C.B.E., K.C., F. C. T. Lord, Esq., and L. N. Bean, Esq., and the report of this Committee, dated 6th July, 1925, appears as Council Paper No. 34 of that year.

In the debate referred to above that gave rise to the appointment of this Special Committee three possible courses had been suggested—

- (a) Abandonment of the scheme
- (b) Transference to another site; and
- (c) Reorganisation.

The Committee recommended drastic reorganisation including a rearrangement of the farms so as to reduce them in number from twenty to thirteen

and so as to provide each farm with approximately 100 acres of flat land. In the matter of finance it was shown that if certain small additional expenditure incident upon the proposed reorganisation were approved the scheme to 31st December, 1923, would have cost £85,826; it was stated that an official valuer, Mr. Mackie, lent by the courtesy of the Government of New Zealand, had placed a value of £29,237 upon the farms and factory but that the Committee considered this should be reduced to £25,000 (£19,500 for farms and £5,500 for the factory). It recommended that the difference between these two figures, namely, £60,826 should be written off as expenses incurred in the establishment of a new industry.

As to control, the Committee recommended that the time was not appropriate for forming the Co-operative Company contemplated in the original Crompton Committee Report and that, for the present, control should remain in the hands of the Government but that a local committee should be set up of four settlers (two nominated by the settlers and two by the Superintendent of Agriculture) with an official Supervisor as Chairman and Secretary and that the complete management of the factory and of butter sales be entrusted to this Committee. The report is replete with detailed recommendations but the main ones are those briefly referred to above. It may be of interest to note that the Committee without definitely recommending the construction of a road from Korovou to Naduruloulou pointed out the advantages that such a road would confer upon the settlers at Tailevu. Speaking of future development, the Committee concluded that "Hesitation is not now justified on any grounds of finance or policy."

DEBATE ON THE ADOPTION OF THE RUSHTON COMMITTEE REPORT.

A debate in Legislative Council took place on 15th July, 1925 (p. 34, *Hansard*) on the motion for the adoption of this report which was moved by the Treasurer and seconded by the Hon. Alport Barker.

The report had stressed the advantages that would accrue to the settlers if the leasehold tenures could be converted into freehold. In the debate this point was emphasised particularly by the Hon. Alport Barker and the Hon. H. M. Scott and His Excellency the Governor, Sir Eyre Hutson, said: "I would be very glad to recommend to the Secretary of State the proposals . . . in regard to acquiring this property and turning the farms into freehold. The purchase of native land is not strictly prohibited as I understand the position, particularly to the Government and particularly if the Governor can satisfy the Secretary of State that the natives' interest would not be prejudiced thereby."

The note struck in the debate was not an optimistic one but infinitely less doleful than on the occasion in 1922 of the debate on the motion to adopt the Scott Commission Report or on the occasion two years later of the debate that led to the appointment of the Rushton Committee to consider the future of the scheme. This tempered optimism in regard to the scheme is brought out in the Governor's speech as follows: "The report recommends further expenditure to a limited amount and, I regret to say, to my mind a doubtful chance either of the settlers making good in the end without further capital or the general taxpayer really recovering indirectly any substantial portion of this expenditure."

The report was adopted, subject to the condition that His Excellency reserved to himself the right to veto any of the recommendations which after consideration had been given should not in the opinion be adopted.

PROGRESS REPORT BY THE COLONIAL TREASURER.

By 25th May, 1926, the principal recommendations of the report had been carried out and a progress report by the Colonial Treasurer, together with an attached memorandum by the Acting Superintendent of Agriculture, was laid on the Table (Council Paper No. 15 of 1926).

The twenty farms had now been reduced to thirteen and each tenant had approximately 100 acres of flat land.

On the financial side the report disclosed that the scheme had now cost £86,933 of which £15,550 had been charged against loan funds and £71,383 charged as final expenditure against revenue.

As to control, it was recommended with a view to getting one step nearer to the formation of a Co-operative Company that the Supervisor and the Factory Manager be given full administrative joint responsibility, subject to the general direction of the Acting Superintendent of Agriculture, and that an Observing Committee of two soldier settlers and one outside supplier, all named by the Government, be appointed. This arrangement was approved and put into effect.

Two points in this report are not touched upon in previous ones and both indicate that considerable progress had been made toward establishing the dairy industry in the Colony since the Tailevu scheme was initiated in the autumn of 1920. In the first place, it is reported that considerable quantities of cream are being delivered to the Tailevu factory by outside suppliers who have had no Government assistance whatever. Secondly, it is reported that Fiji butter from the Rewa factory has made an initial bow in the Honolulu and London markets, that the consignments were graded within two points of New Zealand "superfine" and that they were reported upon very favourably.

The Acting Superintendent of Agriculture who had visited Tailevu for the first time came to the conclusion that: "there is to-day a reasonable chance of Tailevu becoming a permanent dairying area. The two outstanding points, seeming to indicate that the more important difficulties have been overcome, are the enthusiasm of 85 per cent. of those in the scheme and the fact of there being seven outside suppliers, with good prospects of others."

FURTHER DIFFICULTIES.

A further series of disappointments occurred during the next six months. These formed the subject of a Memorandum by the Treasurer printed as Council Paper No. 35 of 1926, and of a somewhat depressing debate in Legislative Council on 31st May (p. 42 to 48 *Hansard*).

Cash to the value of £235 4s. 10d. was stolen from the scheme safe; two of the most experienced soldier settlers left the scheme and went to Navua; 257 boxes of butter held in storage became unfit for sale as first class butter and had to be sold at greatly reduced prices; and the settlers asked that further concessions be granted in the form of reduction of rents and of the capital value of farms. The debate was concluded by Council granting the concessions previously urged by the Hon. H. M. Scott, the chief of which were the reduction of rents from 5s. to 2s. 6d. per acre for flat lands, the reduction of capital value of the farms from £1,500 to £1,000, and appropriating from General Revenue the sum of £2,500 to meet the unforeseen additional expenditures for the year.

CHANGE OF MANAGEMENT.

A slight change was made at this time in the management. The Manager at Tailevu was dispensed with and his duties taken over by Mr. A. B. Ackland,

subject to supervision of the Superintendent of Agriculture in technical, and of the Colonial Treasurer in financial matters, this arrangement having continued in force until the present time. The Observing Committee already referred to has also been extant and from time to time has taken an active interest in the management of the factory and of the scheme generally.

GOVERNOR'S MESSAGE No. 5 OF 1927.

For a year and a half the reorganised scheme carried on without the aid of Commissions, Select or Special Committees and was not heard of until 13th October, 1927, when it came up for further consideration in the Governor's Message No. 5 (Council Paper No. 63 of 1927). This document is notably different in tone from most of those referred to in this history of the scheme and shows that at last the many difficulties were being overcome. Better cold storage facilities at Tailevu were now available and Leylands & Compnay in Suva who had become the agents had agreed to provide modern facilities capable of dealing with butter for local sale and for export. Losses on butter through faulty storage had become fewer and the annual deficit on working account had reached the vanishing point.

The Message states that the total capital expenditure on the scheme is estimated at £84,076 of which £58,350 has been written down with the approval of Legislative Council and of the Secretary of State and that in addition there has been a total working loss of £5,150.

The Superintendent of Agriculture in an annexure to the Message had recommended—

- (a) a further two-year trial of the scheme with management unchanged;
- (b) filling vacant farms with experienced dairy farmers;
- (c) attempting to convert the scheme into a co-operative one at the end of 1929; and
- (d) building without delay the road from Tailevu to Naduruloulou.

These recommendations were approved by His Excellency who embodied them in the Message.

The debate on the motion for the adoption of this Message (pp. 109-119, *Hansard* 1927) was not of the gloomy kind and the Message was adopted unanimously. The debate itself was actually on a side issue, namely, how best to secure some return to General Revenue for the increased value of the lands traversed by the proposed road and no serious objections to the Message were put forward by any members of Council.

It is interesting to note that provision was made in the Message to provide a contingency fund of £500 per annum for the two years in question in addition to the customary loss in rents of £275 5s. but that it has not been necessary to make use of this provision in respect of the first year ending on 30th September, 1928, the books for which have just been closed.

REPORT ON THE PRESENT POSITION OF THE SCHEME AND
RECOMMENDATIONS FOR ITS FUTURE MANAGEMENT.

INTRODUCTION.

In Message No. 5 of 1927 it was provided "that before the expiration of the period ending on the 31st December, 1929, every endeavour should be made to hand over control (by way of sale or otherwise) of the undertaking to the suppliers (both returned soldiers and others) on terms to be approved by this Council."

In order to take the views of the suppliers and to place himself in a better position to advise as to the immediate future of the scheme the Superintendent of Agriculture in company with the Senior Veterinary Officer, made an inspection of the scheme early in 1929 between the dates of 4th February and 11th February inclusive.

2.—ITINERARY.

February 4th.—Rode along or parallel with the new road from Naduruloulou to Korovou.

February 5th.—Inspected the farms of Messrs. Speight, Grieve and Harness.

February 6th.—Inspected the farms of Messrs. Faddy Bros., Smith and Cooper.

February 7th.—Inspected the farms of Messrs. Compain, Jr., Bannister, McMahon and Blanch.

February 8th.—Inspected the farms of Mrs. Wood and of Messrs. Norris, Clifford and Gatward.

February 9th.—Inspected the farms of Messrs. Brake, Sacks and Kellar.

In the evening held a public meeting, to which all suppliers had been previously invited, at Korovou.

February 10th.—Rode to Lodon inspecting *en route*, the farms of Compain, Sr., Melika, and Mrs. Hunt.

February 11th.—Inspected the farm of Mr. Milton Craig and returned by launch to Suva.

3.—SOME COMMENTS ON THE CONDITIONS FOUND ON EACH FARM.

1. Mr. Speight. An experienced New Zealand Dairy Farmer who took up the farm at the top of the Wainewesi originally occupied by Mr. Craig. Since coming to Fiji in March, 1928, Mr. Speight has built a comfortable home on the site of the house that was destroyed by fire, has greatly improved his milking bails and has cleared all flat land on the farm of *Clidemia*. He is now milking 39 cows, expects to milk more next year and has a young pedigree Jersey bull. Has put in five acres of Paspalum on the flats and this is coming on well. He is making good progress.

2. Mr. Grieve took over farm number 4 in July, 1928. Prior to this it had been maintained during its period of vacancy through the kindness of Mr. George Harness who occupies the adjacent farm. Mr. Grieve, senior, is occupying the farm until June, 1929, when Mr. Grieve, junior, expects to take up permanent residence. In the meantime the farm has a neglected appearance and the main paddocks need weeding badly. Close to the house about three acres of land have been recently cleared. Twenty-five indifferent looking cows are being milked but there is some nice looking young stock that will eventually enable culling to be done.

3. Mr. George Harness. One of the original soldier settlers who now has a comfortable home, a well kept farm, and a good dairy herd. Milking 34 cows; expects a slight increase in production this year. Expects to plant four acres of maize for soilage purposes this year to increase production in June, July, and August. Has just purchased a good pure bred bull from Navua.

4. Faddy Bros., both original soldier settlers. Two farms operated as one unit. Seventy acres of para and 50 of ordinary flats. The farm generally in good condition; a fair milking herd is being bred up and the young stock coming along will enable more culling to be done among the old cows. A new pure bred bull has just been purchased from Mr. Kiss.

5. Mr. H. P. Smith. Another original soldier settler. Has a comfortable home and there is plenty of evidence of hard work having been put into the farm. Forty-four milking cows and a small increase is expected. Four acres recently ploughed and sown to *Paspalum* which has not germinated well will be sown to maize. A pure bred bull will be required, probably in August.

6. Mr. Cooper the fifth of the original soldier settlers now on the scheme. A comfortable home. A fine herd of cows with 34 now being milked. Expects to increase the butter fat supply slightly this year. Approximately 100 acres of flat land in use; no ploughing has been done for many months and the pastures are in need of renewing. With more attention to pastures this farm could be made to double its present output of butter fat. Expects to put in five acres of maize for the winter months. The farm is going back slightly.

7. Compain, junior, for a few months has operated the farm vacated by Mr. Costello at the top of the Waimaro. He is a lad of 17 and is living with his mother. Visible progress has been made in the form of fencing and ploughing. There are four acres of new para and plans have been made for three acres to be planted to maize. Sixteen cows are being milked and three heifers are due to calve this year. A new bull is required and I am informed that a brother at Lodon is prepared to give the necessary assistance. Progress made so far is satisfactory.

8. The Lord farm. Vacated by Mr. Lord in May and still vacant. This farm has been allowed to go back steadily in the last few years and the work of clearing will have to be done all over again by the next tenant. The house and fences are in a bad state of repair.

9. Mr. McMahon. A new and energetic tenant from Australia who has taken up the lease of the farm vacated by Mr. Beveridge on account of ill-health. Expects to have the farm in good order by the end of 1930.

10. Mr. Bannister, took up in April, the lease of the farm previously occupied by Mr. Livingston and has made very good progress, the farm now being in better condition than at any time during the last four years. Has $1\frac{1}{4}$ acre of *Paspalum* looking very well and a further $2\frac{1}{2}$ acres either sown or ready to sow. Milking 29 cows and anticipates an increase this year. Thirty acres cleared and in pasture and expects to sow not less than four acres of maize to provide winter feed. At this stage more rapid progress could be made if an advance could be arranged for fencing, clearing and planting another 30 acres.

11. Mr. Blanch, the sixth of the original soldier settlers, has at no time made rapid progress and mentions the shortage of labour as a principal difficulty. Made considerable improvements two years ago and has since maintained the improved position. His cream cheque is still too small to live on comfortably and a further thirty acres should be cleared but he cannot afford to borrow the cash required and is not sure that he could secure the labour even if the capital were to be found. Will require a new bull within six months time.

12. Mr. G. Norris. One of the best farms on the scheme with a comfortable home, good pastures and a fair herd of cows. Milking 52 cows and buying additional young heifers from Mr. Harness. Expects to plant four acres of maize for winter food. Anticipates an increased production of butter fat.

13. Mrs. Bussell. This is not a scheme farm but is one that has supplied the factory from the beginning. It is being managed by Mrs. Bussell and her mother, Mrs. Maitland-Woods, and for two ladies the task is a difficult one. Only part of the farm is in use and the modest cream cheque has declined somewhat in the last three years. The bails have been rebuilt lately and are in excellent order.

14. Mr. Brake. An experienced dairy farmer from New Zealand who took up a farm in August, 1927. Has made excellent progress in clearing land and planting to Paspalum. Milking 18 cows and has sufficient pasture for more. Is now handicapped for lack of capital.

15. Mr. Kellar. This farm has improved greatly in the last three years and will now carry more cows than are available. Milking 33 cows; a steady increase in production has been made in the last three years and Mr. Kellar expects to maintain this increase. Expects to plant three acres of maize to supply winter feed.

16. Mr. Sacks. A small supplier who has recently started dairying and who expects to become a regular supplier.

17. Mr. Gatward. At one time a banana planter on a large scale has now converted his extensive flat lands into dairy pastures and has become one of the largest individual suppliers to the factory. Now milking 62 cows and expects to be milking 80 by the end of the year. Expects to start a second farm of 40 cows on a share basis. Is planting considerable areas to Paspalum. Has sufficient land to develop a third farm.

18. Mr. Clifford. Has 45 acres in use, all free from weeds and growing sensitive plant. Is milking 22 cows and has feed for another 10 but his financial position is such that he is unable either to obtain more stock or to clear additional land and has difficulty in meeting the rent of £15 per annum. The family does all the work on the farm. Lack of finance is the chief difficulty.

19. The Fijian Melika has a most creditable dairy farm at Burerua. He was trained at Navuso and financed from provincial funds. Has twelve excellent cows, a pure-bred bull, good bails and a new cream separator. Started in July, 1928. No fences are required at present and the little pockets of Para grass in the neighbourhood of Burerua would support many times this number of cows.

20. Roberta and Turaga have another native dairy near Lodon. I saw a few of the dry stock which were of good type but did not see the bails or milking herd. The amount of butter fat supplied has increased steadily since 1926 and the amount supplied in 1928 was 2,970 lb, worth about £190.

21. Mr. Compain. Took over Mr. J. L. Hunt's dairy farm near Lodon and in 1928 rose to be the largest supplier of butter fat to the factory thus wresting the laurels from Mr. Gatward who held them for 1927. Mr. Compain was unfortunately absent when the inspection of his farm was made and I was unable to obtain particulars as to his anticipated increase in production. Mr. Compain is clearly doing well, however, and from what I saw of his lands and herd is likely to increase his production in 1929.

22. M. J. L. Hunt. Is now developing another dairy farm nearer Lodon but no butter fat has yet been supplied to the factory.

23. Mrs. Hunt. Has been a small supplier but the supply is so small at present that she prefers to make Ghee for which there is a small local sale.

24. Mr. Milton Craig has improved his pastures very greatly in the last year and now has the making of a good dairy herd. Is now milking between 30 and 35 cows and hopes to be milking 40 by the end of 1929.

4.—SUBSTANTIAL PROGRESS MADE.

This review of the conditions obtaining on the farms of the suppliers shows that substantial progress has been made since the adoption of His Excellency's Message No. 5 of 1927. All but one of the vacant farms have been filled; pastures are being improved by the use of Paspalum, maize is being sown for winter feed, and an increase in production during 1929 and 1930 can be anticipated more especially by the outside suppliers.

5.—PRODUCTION OF BUTTER FAT, 1926-28 INCLUSIVE.

An important change is taking place at Tailevu in that the amount of butter fat supplied by the holders of farms under mortgage to the Government has declined while the production by outside suppliers has steadily increased.

	1926.		1927.		1928.
Scheme	51,356	....	49,062	....	43,720
Outside suppliers .	25,501	....	34,547	....	34,560
	<hr/>				
Total	76,857	....	83,609	....	78,280

The drought in 1928 brought about a decline in production that was unavoidable and the unoccupied scheme farms made matters worse.

With the scheme farms all occupied but one and with so much activity going on among the outside suppliers there are reasons for anticipating a production of 90,000 lb for the calendar year 1929 and it is anticipated that the outside suppliers will increase production more rapidly than the tenants of scheme farms.

6.—A PROFIT MADE ON THE FACTORY WORKING ACCOUNT.

From the beginning the factory has been operated as a unit and independently of the farms. At first it was unduly expensive to operate because the supplies of butter fat were so small. The Profit and Loss Account for 1926 showed a net loss of £908 0s. 11d., which was increased to £1,372 2s. 4d. by the end of 1927, which sum was written off as a final charge against revenue. With the production up to 80,000 lb of butter fat or one-third the capacity of the factory it was clear, however, that the factory could be made to pay its way by reducing the price for butter fat to an economic figure and on my recommendation this was done. This action marked the end of the "spoon feeding" period and the accounts now closed for 1928 disclose a profit of £426 12s. This is particularly satisfactory in view of the fact that the financial year was altered and that the period in question is one of nine months only, including the drought months when production fell off badly for lack of pasture.

7.—DISPOSAL OF THE PROFITS.

The Colonial Treasurer visited the scheme during the writer's absence in the Solomon Islands; he discussed the question of the payment of the then possible bonus with most of the suppliers who agreed with unimportant amendments to deposit half in a rest account to form the nucleus of a fund for floating the proposed Co-operative Company and to take the balance in cash. I found that this plan met with general favour and I was able without difficulty to obtain the consent of practically every supplier. In the case of those with very small cream cheques I did not urge the plan as it was obvious that the full amount due should be paid in cash.

8.—PLANS FOR FUTURE MANAGEMENT.

(a) Message No. 5 of 1927, stipulates that before the end of 1929 "every endeavour should be made to hand over control (by way of sale or otherwise) of the undertaking to the suppliers (both returned soldiers and others) on terms to be approved by this Council.

(b) When this final step is taken it will be necessary for the suppliers to assume financial responsibilities in respect to the factory which up to the present time has been lent by Government without any charge therefor.

(c) The conditions under which the Associated Banks of New Zealand assist in the formation of Dairy Companies are as follows, the information having been kindly supplied to me by the Manager of the Bank of New Zealand:—

- (1) *Paid up Capital*.—That at the outset the Shareholders provide in cash 25 per cent. of the estimated capital outlay on land, buildings, plant, and other fixed assets. That if the capital outlay exceeds the estimate or if extensions be carried out and further expenditure incurred on Capital Account, additional capital is to be provided in the same proportion to the new expenditure.
- (2) *Shares in other Companies*.—That, should the Company take up shares in any other Company, the Shareholders of the new Dairy Company be required to subscribe for a similar amount in shares of their own Company and to pay for these shares on the same terms as the Dairy Company is to pay for the shares in the other Company.
- (3) *Subscribed Capital*.—That Capital be subscribed to the extent of at least two-thirds of the amount of the advance asked from the Bank and that this proportion be maintained by the issue of further shares if the advance should be subsequently increased.
- (4) *Depreciation*.—That before the distribution of the year's surplus depreciation be written off all assets to the extent of at least the amount permitted by the Income Tax Department to ordinary companies doing similar business. This is at present 5 per cent. on plant and machinery, 2 per cent. on brick or stone buildings, and 3 per cent. on wooden or iron buildings. The amount so written off to be applied in permanent reduction of the overdraft limit.
- (5) *Annual Reductions*.—That so long as the Company is indebted to the Bank there be withheld from distribution to the suppliers at least 1d. per lb of butter fat supplied. This amount to be either applied in payment of the supplier's liability for Unpaid Capital, or written off the Company's assets (in addition to the amount mentioned in para. 4) or credited to a Reserve Fund or some internal account. Thus if one farthing per lb is held back monthly from the milk money and being credited to the Supplier's Share Accounts, three farthings per lb is to be held back before payment of a bonus and dealt with as mentioned in this paragraph.
- (6) *Security for Advances*.—That all advances be secured by Joint and Several Guarantees of suppliers, and by security over all assets of the Company, including uncalled capital.
- (7) *Re-arrangement of Capital—Extension of Operations*.—That in the case of existing Companies which are rearranging their capital, extending their operations or reconstructing, they are to be required to do so on a basis not less adequate than that laid down for new companies.

Note.—On 21st August, 1922, the Associated Banks agreed to refrain, in the meantime, from enforcing the repayments laid down in para. 5, provided the companies made reductions in the following basis:—

When the payment to suppliers for the whole season does not exceed 1s. per lb of butter fat	$\frac{1}{2}$ d. per lb.
When payment exceeds 1s. and does not exceed 1s. 9d. per lb of butter fat	$\frac{3}{4}$ d. per lb.
When it is in excess of 1s. 9d. per lb of butter fat	1d. per lb.

This arrangement applies only to factories engaged in the production of cheese and/or butter, and is to be reviewed from time to time.

Companies which put all their exchange business through their Bankers will be allowed best rates as regards exchange and interest on overdrafts, but those companies which do not put all their exchange business through their Bankers will be charged on their overdraft at least $\frac{1}{2}$ per cent. above the best interest rate.

"All their Exchange Business" means the negotiation of drafts in the Dominion against produce shipped, and, if such produce is shipped on consignment, the remittance of the resultant surpluses from London through the Companies' Bankers.

No Bank will take over a Dairy Company's account from another Bank because of dissatisfaction on the part of the Company arising solely out of these stipulations.

It was agreed that the transfer of no Dairy Company's account, debtor or creditor, shall be accepted by one Bank from another until the reasons for such transfer have been considered by the Associated Banks and the reasons for the proposed transfer of the account approved of as not being contrary to existing arrangements.

Surpluses in London.—All Dairy Companies are required to arrange that any surpluses accumulating in London be remitted out through their own Bankers, and that, as usual, all drafts drawn against shipments must be negotiated through the Companies' Bankers.

(d) As the factory and plant have been valued at £5,500, it would be necessary under clause 1 for the suppliers to find £1,350 in cash.

(e) Under clause 4 it would also be necessary to provide a sum estimated at £220 for annual depreciation of factory and plant that the suppliers do not now provide.

(f) It would also be necessary for the suppliers to pay the salary of a Business Manager who would be responsible to the Directors. Although the office would be a part-time one, it is doubtful whether anyone could be found to do the work for less than £250 per annum.

(g) When the Co-operative is formed, therefore, suppliers will have to find £1,350 in cash and £220 + £250 = £470 per annum that they do not now have to find.

VIEW OF THE SUPPLIERS.

(h) These matters were discussed individually with most of the suppliers during the week, and at a public meeting held in the School House on the evening of 9th February, the following suppliers were present: Messrs. Bannister, McMahon, Morris, N. W. Faddy, Blanch, Clifford, Kellar, Brake, Smith, H. S. Faddy, Cooper, Gatward, Harness, Mrs. Bussell and Melika,

The following resolution moved by Mr. Norman Faddy and seconded by Mr. Cooper was passed unanimously:—

“Resolved that Government be requested to continue control as at present for a further period of about two years or until the reserve fund has been built up to one-fourth of the capital value of the assets and that steps be then taken to form a co-operative concern.”

9.—RECOMMENDATIONS.

(1) The proposal contained in this resolution is a reasonable one that represents, I believe, the unanimous wish of suppliers and I recommend that it be approved. The scheme year closes on 30th September and the books are ready for audit about the middle of January. I interpret the above resolution to imply, therefore, that if the reserve fund now accumulating does not reach the total of £1,350 at a prior date Government should do everything in its power in February, 1931, to assist the formation of a Co-operative Company linked with a bank.

(2) In view of the substantial progress made, I recommend that the suppliers be held responsible as from 1st October, 1928, for any losses on factory working account made subsequently to that date and that conversely all profits on the factory working account made subsequently to that date shall be distributed to the suppliers *pro rata* as cash, all or part of which should if possible be deposited by the suppliers in a fund for the purchase of the factory.

(3) I recommend, further, that the factory and machinery be loaned as heretofore to the suppliers until such time as the Co-operative Company is formed—estimated to be in February, 1931, or at a prior date.

(4) The factory and assets have been valued at £5,500. I recommend that one of the Banks be invited to value these in February, 1930, so as to provide a definite basis for forming a Co-operative Company at a somewhat later date.

(5) Two years ago it would have been sound financially to close the factory at Korovou and to send cream to the Rewa factory. An important change has since occurred in the very large increase of butter fat coming from suppliers along the Lodon Road. In 1928, these suppliers sent 16,087 lb to the factory, the total supplied being 78,280 lb and, as these people would be debarred by distance from supplying the Rewa factory, it would no longer be sound financially to close the Korovou factory and I recommend accordingly.

LANTANA CROCEA.

By CHAS. R. TURBET, B.V.Sc., Senior Government Veterinary Officer. THE name of the common Lantana plant in the vicinity of Suva has always been considered to be *Lantana camara* and, as such, was referred to in the feeding experiments carried out by the writer to determine the cause of Dermatitis of Cattle in Fiji.

Dr. Seddon, of the Veterinary Research Station at Glenfield, New South Wales, could not agree that *Lantana camara* possessed toxic properties. He stated, however, that *Lantana crocea* was, undoubtedly, very toxic.

This led to the following correspondence with Dr. Darnell Smith, Director of the Botanical Gardens, Sydney:—

Sir,

11th January, 1929.

For many years a plant of the genus *Lantana* has been very prevalent in Fiji. It has always been known here as *Lantana camara*. I now have reason to doubt this earlier

diagnosis however, and consider that the plant might be *Lantana crocea*, or that both *L. camara* and *L. crocea* exist here.

2. My opinion is based on the description of *Lantana crocea* given by F. Manson Bailey in the "Queensland Flora," Part IV, page 1171.

3. The common plant here corresponds to that description in its manner of growth being shorter and more compact than some *Lantana* when growing in the open and not shaded. The flower colours also correspond to *L. crocea* although I have never seen a blue flower. The colours are: white, white with yellow centre, pink with yellow centre, red with yellow centre and red.

4. I have also definitely produced poisoning of cattle by feeding the local plant. At the time I had no doubt but that it was *L. camara*. Seddon, however, cannot agree that *L. camara* has poisonous properties. I would be much obliged then if you would give me your opinion as to whether the plant is *L. camara* or *L. crocea*.

5. I am forwarding pressed flowering shoots of the plant in the same mail.

Trusting that this request is not encroaching too much on your valuable time and thanking you.

I have, &c.,
C. R. TURBET.

And the following reply from Dr. Darnell Smith:—

The specimens forwarded for identification seem to belong to the species or sub-species *Lantana crocea*. It is extremely difficult to distinguish this from *L. camara* in the dry state. When the living plants are examined and the flowers are quite fresh there is no difficulty in separating the two forms. *L. crocea* seems to be identical with our garden forms labelled *L. camara* var. *Rougiere-chauviere*. They are not so tall and are more compact than the common *L. camara*, but, except for the colour of the flowers (easily detected when the flowers are fresh), there is scarcely any other character whereby they can be distinguished one from the other. The corolla of *L. crocea* is slightly longer than that of *L. camara*, but in the herbarium specimens even this character is hard to define.

G. P. DARNELL SMITH.
Director.

INTRODUCTION OF SPALANGIA CAMERONI, PARASITE OF THE HOUSEFLY, INTO FIJI.

THROUGH the courtesy of Mr. Fullaway of the Department of Agriculture, Hawaii, three consignments of housefly parasites have been received from that country. This material, when bred out, proved to be *Spalangia cameroni*, a species, which, in Hawaii, uses Hornfly puparia, in cow droppings, as a host.

These parasites are doing well in our Laboratory where they are breeding in both housefly and Sarcophagid puparia. Both of these live in cow droppings, the former generally leaving to pupate in the soil, the latter remaining, as a rule, within the dropping, which is also the habit of the Hornfly. Whether this difference in habits between the Fijian housefly and its Hawaiian host will seriously affect its efficiency, remains to be seen. It seems probable, however, that it will find difficulty in reaching a large percentage of the fly pupæ and that further predators and a larval parasite are desirable, if appreciable reduction in the numbers of this disease-carrying pest is to be obtained.

Liberation of the new introduction, now number over 6,000, the bulk of which have been released about Hills' dairy in Circular Road, but 500 were set free at the Golf Links, a further 400 four miles out on the Rewa Road, and 250 at Sawani.

HUBERT W. SIMMONDS,
Government Entomologist.

THE LIFE HISTORY OF TELEONEMIA LANTANAE.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

INTRODUCTION.

THIS Tingid bug, which is a native of Mexico, was introduced into Hawaii by Koebele, in 1902, with the object of assisting in the control of the weed *Lantana camara*. In November of last year (1928) a strong colony of 10,000 was collected by the author in Oahu, Hawaii and, thence transported to Fiji. These are now being bred and liberated in this country, some details of which were reported in our last issue.

In the course of this work a number of facts concerning the life history of the bug have been worked out and these are now placed on record.

The life cycle is incomplete, in that we have no definite knowledge as to the period which elapses from when the insect mates until it commences to oviposit. Indications are, however, that it is very short.

There is a certain amount of variation in the time taken by the individuals in any one batch to reach maturity, which in the laboratory, showed a minimum of ten days. The egg stage was found to be fairly constant in summer weather at about seven days, so that from egg to adult can be completed in seventeen days, pairing can occur within twenty-four hours and it seems certain that from one generation to the next occupies less than four weeks probably only three. Thus it will be seen that under favourable circumstances, the insect should be capable of breeding up very rapidly. It has, however, in Fiji, met with certain powerful enemies, which are retarding its spread and these will be referred to more fully later on.

LIFE CYCLE.—OVIPOSITING.

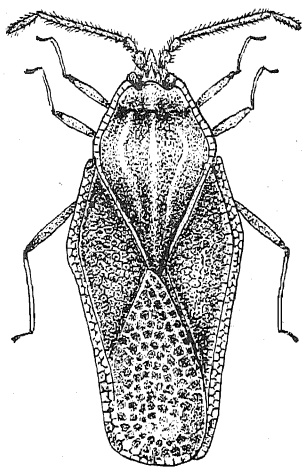
The adult *Teleonemia* sucks the juices of the underside of the mid, or one of the major, veins of the lantana leaf, generally selecting one of the younger and more succulent pairs. This action causes a brown discolouration and corking of the affected portion, whilst the leaf curls inwards, often with considerable distortion.

The eggs are deposited singly and upright, within the wounded tissue, any number up to about 25 or 30 being placed in one mid-rib. I have occasionally observed eggs placed further along a vein, away from the wound, or on an unsucked leaf, but, on one occasion, this happened after the female had been disturbed, which is probably usually the case when this occurs. I also once observed an egg lying openly on the surface of a leaf.

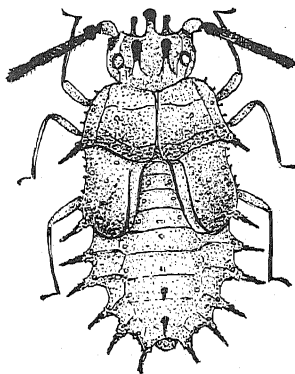
Ovipositing in the few instances where it occurred in the laboratory took place at night. It has not been observed in the field, but probably this is normal.

THE EGG.

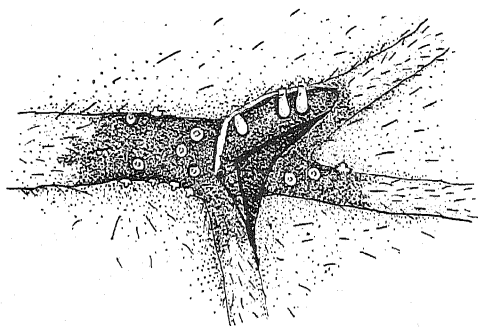
The egg is pale-yellowish and shaped much like a sparklet syphon cartridge, but somewhat flattened on one side. It is contracted at the top end, where the chorion is drawn out into a series of spine-like processes forming a collar round the operculum. Placed over this, and projecting above the rib of the leaf, is a nipple-like structure divided into two lobes, looking like a brownish-white pustule or the fruiting body of some fungus. [Imms, speaking of the Tingidæ, states: "The eggs are frequently inserted upright in the plant tissue, and are invested in a brown viscid substance, which hardens to form a cone-like elevation on the surface of the leaf." (Text-book of Entomology, Imms, page 348).]



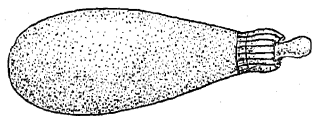
1



2



3



4

1.—Adult *Teleonemia lantanae*, Dist x 16.

2.—Nymph of *Teleonemia lantanae*, 4th instar x 20.

3.—Section of midrib of Lantana leaf, laid open to show eggs of *Teleonemia* "in situ" x 16.

4.—Egg of *Teleonemia lantanae*, Dist. greatly enlarged (about 170 x).

Hubert W. Simmonds, del.

The total number of eggs laid by one female is unknown but several batches of nymphs, separated in age by a few days and feeding together, frequently accompanied by a still ovipositing adult, indicate that she deposits several batches at short intervals. The number of eggs in one batch averages somewhere between 20 and 30. The duration of the egg stage, in normal summer weather, averages seven days.

THE NYMPH.

The number of nymphal instars is still uncertain. In most cases only five have been observed, but in one specimen, bred in the laboratory, six occurred. When newly hatched the nymphs are very minute and it is easy for them to cast their skins which may escape observation.

The following life history was based upon the six instar specimen mentioned above. It was bred from an egg laid in the laboratory, taking twelve days from egg to adult.

First Instar.—When first hatched the young nymph possesses an elongated campodeiform type of body of a whitish colour, which, however, quickly contracts to the typical bug shape, whilst the colour becomes pale yellow, with darker patches of food showing through the abdomen as soon as feeding commences.

As a rule they settle down for this purpose within the shelter formed by the young curled leaf, but on older and less warped ones they make their way to the junction of two major veins, quickly causing it to become contorted at this point, whilst owing to the removal of the contained juices it shows whitish or pale-yellow on the upper surface. On the under surface the drops of brown excreta deposited by the nymph are particularly characteristic and give a speckled darkened appearance to the attacked portion.

The duration of this stage seems very variable, but was in this case between 24 and 36 hours.

Second Instar.—Very little difference could be observed between the second and first instar and in the case under review this stage only lasted 24 hours.

Third Instar.—This stage lasted 36 hours. There was a little, but noticeable increase in size and also some darkening.

Fourth Instar.—In this stage, which lasted 47 hours, slight traces of the wing buds could be observed, the colour also was darker.

Fifth Instar.—In this stage the wing buds become well developed, occupying one-quarter the abdominal length. In the specimen under review this instar lasted just under three days.

Sixth Instar.—In the final nymphal instar the wing buds extend to half the abdominal length. The nymphs are very dark in colour and often feed on the upper surface. In both this and the preceding instar they show a tendency to feed on older leaves than in their earlier stages. This instar lasted three days.

The following are the details of this specimen, which took twelve days from egg to adult:—

Egg laid night of 17th to 18th January, 1929.

Egg hatched 9 a.m. of 25th January, 1929.

First moult night of 26th to 27th January, 1929.

Second moult night of 27th to 28th January, 1929.

Third moult 10 a.m. of 29th January, 1929.

Fourth moult 9 a.m. of 31st January, 1929.

Fifth moult night of 2nd to 3rd February, 1929.

Adult 9 a.m. of 6th February, 1929.

Mated 9 a.m. of 7th February, 1929.

A second life cycle, based on a five nymphal instar specimen, which is probably the more normal, is as follows:—

Hatched night of 17th to 18th February, 1929.

First moult night of 18th to 19th February, 1929.

Second moult night of 20th to 21st February, 1929.

Third moult night of 22nd to 23rd February, 1929.

Fourth moult, 25th February, 1929, 9 a.m.

Adult, 1st March, 1929, 8.30 a.m.

Taking eleven days from hatching to adult, which is about the average.

There was a certain amount of variation in the time taken by various individuals to mature, but in the laboratory ten days was the minimum for the nymphal instars, with a further seven for the egg stage, making seventeen from egg to adult.

ADULT.

The newly emerged adult is, as in all the earlier stages, white when it leaves the cast skin of the last nymphal instar. After an hour or so it will be found to have gradually assumed its normal brown appearance.

Like the nymphs, the adults suck the juices of both leaves and young lantana stems.

Pairing takes place within a very short time of reaching the adult stage, having been observed in the case of a bred female and wild male twenty-four hours later. It frequently, but by no means always, appears to occur on the leaf upon which the female underwent her final metamorphosis. Whether the male is generally of the same colony or whether a flight is first essential I have not yet been able to ascertain. The adults fly freely with a rapid motion of the wings, and it was found that the first generation bred in the open quickly scattered over a circle of perhaps 100 yards in diameter.

The period which elapses from pairing to ovipositing is uncertain as I have been unable to induce bred females to deposit their eggs under observation and it is possible that flight is a necessary factor, although the heavy infestation of one bush, whilst an adjoining one remains free, seems to negative this.

NATURAL ENEMIES IN FIJI.

Teleonemia has undoubtedly found considerable difficulty in establishing itself in Fiji. Strong colonies of over 1,000 adults have disappeared, or in other cases are, after about three generations, only to be found in very small numbers. This may be in some cases partially due to scattering, but generally, it seems, to the presence of powerful natural enemies. This is indicated by the number of colonies which show the cast skins of the earlier instars and disappear without leaving those of the final stages. These enemies are predatory and, having destroyed their victim move on and are thus difficult to discover.

Spiders probably take a toll and I have found adults in their webs, also under some circumstances ants undoubtedly destroy a certain number.

The above are, however, apparently of very minor importance as compared to the *Lygaeid* lantana seed feeding bug, *Germalus pacificus*, which seems to have found in *Teleonemia* a very desirable food. The first observation was made on 10th January, when a nymph of *Germalus* was observed with its rostrum in the dead body of a *Teleonemia* nymph. The *Germalus* was caught, but it dropped its victim, so that it was not possible to examine the latter.

The captured *Germalus* nymph was placed in a jar with another *Teleonemia*. The attack was not observed in this case, but the *Teleonemia* nymph was found dead two hours later. The experiment was repeated and in several instances the attacks were observed. They were not always successful, the *Teleonemia* taking alarm at the first thrust of the *Germalus* nostrum. This thrust occurred in one case between the joints of the antennæ and in another, in the leg. In both these cases the *Teleonemia* escaped but seemed restless, as if poisoned, and did not settle down to feed again for twenty-four hours.

In one case observed the *Germalus* attacked a first or second instar *Teleonemia*, piercing its abdomen dorsally and then raising it into the air, held it there until life was extinct.

There is also little doubt that the *Germalus* sucks the *Teleonemia* eggs, the predator having on two occasions been observed with its rostrum into the egg mass, which when removed gave low percentages of hatching (about 50 per cent.).

There is thus little doubt that in *Germalus pacificus* the introduced *Teleonemia* has found a powerful enemy and in liberating colonies it has been found advisable to place them on small isolated bushes rather than on the big continuous areas. Whether they will breed up in sufficient numbers to offset the *Germalus* remains to be seen.

An unidentified *Capsid* has also been observed under circumstances which suggest that it is also predatory, but in any case this is a scarce insect and of little account as compared to the *Lygæid*.

PRESENT POSITION OF *Teleonemia* IN FIJI.

At the time of writing (April, 1929), the bug is well established on the Reclamation and at Circular Road in the Suva District, whilst a newer colony at three miles on the Tamavua Road is doing well. Other colonies have been liberated at Lami (three places), opposite the Asylum, Rewa Road (four miles), and Tamavua Road (two miles), also one at Sawani.

Strong colonies have been sent to Savusavu, Natewa Bay, and Taveuni. The present condition of these is, however, not yet known.

Note.—The species of *Lantana* common around Suva has recently been identified as *L. crocea* and not *L. camara*, as formerly supposed. See page 34 of this issue.—H.W.S.

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1929.

[No. 2.

AGRICULTURAL JOURNAL

*Issued by the
Department of Agriculture, Fiji.*

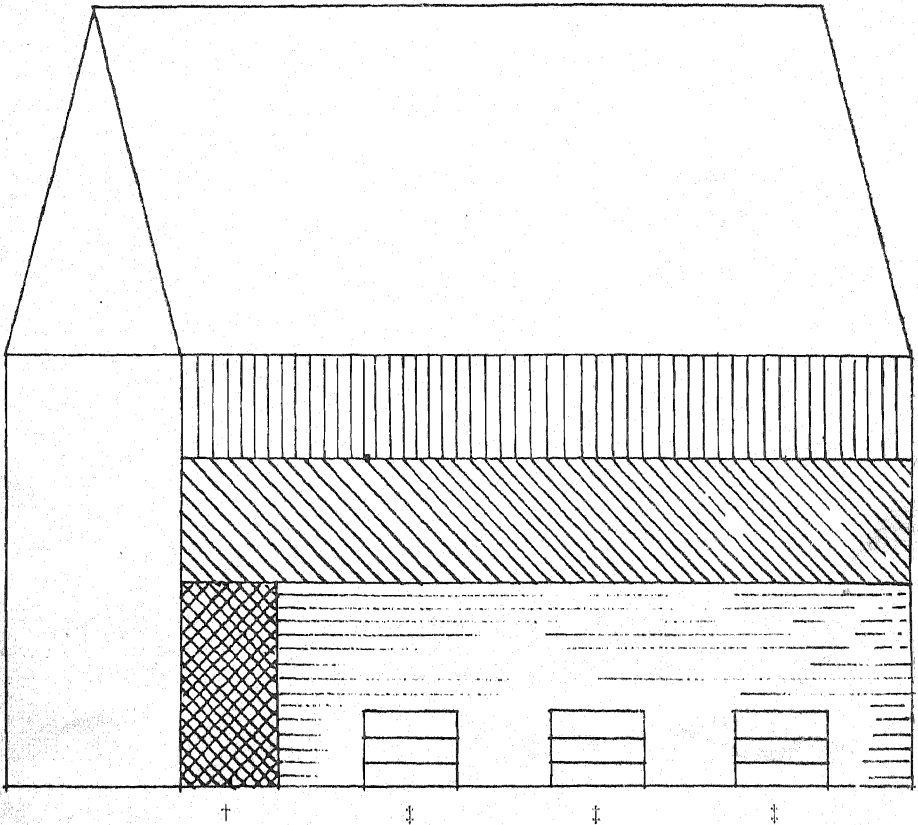
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1929.

COPRA DRYING SHED.

Roof of galvanised iron or cadjain.



* Platform allowing half inch to one inch spaces between the slats.

† Opening under platform to allow of access below for laying the coconut shells and lighting the fires.

‡ Steps outside of wall to permit of copra being rapidly placed on and removed from the platform.

§ Front wall 5-6 feet high; back wall to eaves of building. The front wall sometimes is flush with the platform, but in other cases it is some six inches above the level of the platform, and if so arranged is reported to result in the prevention of some loss of heat.

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 2.]

SECOND QUARTER, 1929.

[No. 2.

EDITORIAL.

STAFF NOTICES.

Information has been received that Mr. A. C. Barnes, B.Sc., Assistant Director of Agriculture, Zanzibar, has been appointed as Superintendent of Agriculture, Fiji, and is expected to arrive on August 9th.

Mr. A. B. Ackland, Chief Clerk, has been appointed to act as Assistant Superintendent of Agriculture pending the arrival of the new Superintendent of Agriculture, as from June 26th.

Mr. H. W. Simmonds, Government Entomologist, to act as Mycologist during the absence of Mr. J. G. C. Campbell on leave, as from 1st June.

Mr. H. M. Stuchbery, B.V.Sc., Melb., will act as Senior Veterinary Officer during the absence of Mr. C. R. Turbet on leave.

The Coconut Entomologist, Mr. R. W. Paine, arrived in Java on June 8th where he will undertake investigations regarding the coconut spathe borer, *Tivathraba* sp.

THE DRYING OF COPRA.

By F. A. STOCKDALE, Assistant Agricultural Advisor to the
Secretary of State for the Colonies.

THERE is an indication that information is required in regard to the preparation of copra. Proposals for research work in some Colonies have been considered and have been sanctioned. Mr. Sampson of Kew and the Imperial Institute have prepared memoranda on the question of copra drying, but it is thought that these memoranda can, with advantage, be supplemented by notes on the systems of copra preparation common to Ceylon.

The picking of coconuts takes place every two months in Ceylon. The method employed is either climbing the palms and cutting down the two lower bunches or, more commonly, from the ground by means of a sickle-shaped knife attached to the end of a long bamboo. On a well managed cultivation, the nuts of the two lower bunches are mature and are picked at each picking round, but, of course, judgment of maturity is essential and can only be settled by the pickers and by the supervisory staff. After harvesting, the nuts are heaped in central places in the plantation for six weeks to two months for drying, as this process facilitates the husking work

and the subsequent extraction of the kernal. Husking is done on an iron spike firmly fixed in the ground and each husked nut is then split with a large knife or cutlass into halves across the shorter axis and placed on the ground to dry, concave side upwards. The kernel as it dries separates itself from the shell and can then be removed for the manufacture of copra. This initial drying to separate the kernel from the shell is usually done in the open and is reasonably rapid in sunny weather, but there are instances in wet districts when this initial separation of kernel from shell is effected in the drying sheds by means of heat.

In the dry districts of Ceylon, where there is certainty in regard to weather conditions, the copra is prepared by drying in the sun, but in the wetter districts, and these embrace the greater part of the coconut-growing areas, sun drying is only done in the drier months of the year, and during the wet weather, or during those months when the weather is uncertain, artificial drying is resorted to.

Artificial drying is done on a few larger estates in the upper storey of a properly constructed factory heated under the flooring of the upper floor by means of hot air drawn or driven through a series of galvanised iron pipings. The principle followed is similar to that adopted in the earlier days for heated tea factories and consists of a hot-air generating plant with engine-driven fans for providing for the circulation of the hot air. Such a system has recently been installed in the Central Experimental Station of the Department of Agriculture at Peradeniya, and details of that station's factory equipment can be secured from the Director of Agriculture, Ceylon.

The most general system of artificial drying, and the one more suitable for small holdings on account of its inexpensiveness, is the system of copra kilns or drying sheds. This kiln consists generally of a small shed made with brick walls and pillars surmounted by a galvanised roof, or with mud or wattle and mud (daub) walls surmounted by a roof made of plaited halved coconut-leaves (cadjans). In this shed is fixed a platform consisting of wooden slats—often made of the split stems of the areca nut palm. This platform is placed about 5–6 feet above the floor level and on it the copra is placed for drying. The height of the platform above the ground and the fire is a matter of practical importance and varies in different districts—probably on account of slightly varying average air temperatures and on account of the often greatly varying degrees of humidity. On the mud floor of the shed dried half coconut shells are arranged in rows, the concave of the one being fitted into the convex of the other, and each row alternating thus:—

	(	(	(	(	(	(	(	(	(	(	(	(	A. row 1.
B.	)	)	)	)	)	)	)	)	)	)	)	)	row 2.

&c.

These shells burn slowly and with practically no smoke and, in order to secure an even burn over the whole building, row 1 would be lighted at A. and row 2 at B., the burning thus taking place in every alternate row in opposite directions. The number of rows to be lighted and their position throughout the shed can be ascertained by experience. The half coconuts either shortly after being halved or, preferably, after they have dried in the sun for a few days, are placed on the slatted platform with the kernels still in the shells, or in good weather the kernels alone are put on the platform after having been removed from the shells. A thickness of three to four layers of such shells or kernels are placed on the platform, but it is wiser not to place them too thick. The fire of dried shells is made as described above. If kernels in the shells are placed on the platform they are

ultimately removed from the shells and drying continued until it is completed, usually with 5-6 days. Finally, the dried copra is taken to a store and sorted over into different grades, No. 1 consisting of thick, clean and full half nuts, No. 2 consisting of thin, soft, full or broken half nuts, and No. 3 consisting of thin, soft dark pieces.

The accompanying sketch may tend to illustrate such a copra shed as that above described. It is a common feature of Ceylon coconut-growing areas and produces quite a good quality copra if mature ripe nuts are alone used. If green nuts are picked either carelessly or purposely for the production of fibre from the husks a low grade copra is turned out, and this in no case should be mixed with a good quality product.

Experiments were made by the Department of Agriculture in Ceylon with the object of improving the copra drying sheds. These experiments consisted of no change in principle but simply included the provision of sliding trays instead of the fixed platform, or, alternatively, a sliding roof structure. These improvements were suggested by the design of cacao-drying houses or boucans in the West Indies, and would enable either sun drying or artificial drying to be utilised in the same building. The experimental developments were successful and good copra was produced in them, but they have not been adopted by copra producers, who are satisfied with their existing practices and types of drying houses.

THE NATURAL CONTROL OF THE COCONUT SCALE.

By T. H. C. TAYLOR, Entomologist, Coconut Committee.

PROGRESS REPORT.

THE importation into Fiji of several species of Coccinellid beetles which feed on the Coconut Scale (*Aspidiotus destructor*) has already been recorded in this Journal (Vol. I, No. 2). During 1928 the beetles were distributed to all the islands on which scale is known to occur, and it is now certain that they are well established in Fiji.

An opportunity has recently arisen of revisiting certain districts (notably Savusavu and Wainunu) in which the beetles were first liberated about a year ago. At that time the scale was doing a great deal of damage to the coconut trees in both of these districts and was spreading to such an extent that it became a serious menace to all planters. At the present time (May, 1929), the pest is no longer spreading and appears, in fact, to be almost completely exterminated even in those localities where it was so prevalent that the yield of nuts was reduced almost to nil. Moreover, all the trees already show a marked improvement in their general condition. They are rapidly losing the sickly yellow colour which is no characteristic of the ravages of this insect and are regaining their normal healthy appearance, the young leaves which have opened since the advent of the beetles being entirely free.

It is remarkable that these very satisfactory results should have been attained in so short a time. It was originally anticipated that a period of at least two years would have to elapse before any marked improvement could become apparent, and yet there is every indication that within a year a complete control has been effected. In fact, the predatory beetles imported to attack the scale promise to be as rapid in their action and quite as efficient as the parasites imported to combat *Levuana*.

On Muanicula estate on the west bank of the Wainunu River a very severe outbreak of scale occurred, particularly on a hill about $1\frac{1}{2}$ miles from the mouth of the river. Mr. Mark Dods, the manager of this estate, who has taken a keen interest in the campaign and has rendered much assistance in the work, expresses the opinion that the scale is now completely suppressed at Muanicula, and the trees in the infected areas certainly promise to produce a normal crop of nuts next year. On the other side of the river (Captain Robbie's estate) scale was plentiful during 1928. A severe outbreak occurred on the coconuts on the plateau where tea is grown. The beetles have, however, spread across the river from Muanicula (without artificial aid) and are destroying it rapidly. There was also a small isolated outbreak at the mouth of the Wainunu River, on the east side, opposite Mr. Dods' house. The beetles have discovered this outbreak and are now abundant there, despite the fact that they had to spread about two miles from the place where they were originally liberated in order to reach it.

In the Savusavu district the results obtained have been even more remarkable. Probably the most severe outbreak in the Colony was that which occurred around Wailevu, on the north side of Savusavu Bay. There was a continuous belt of the disease all along the coast for a distance of about three miles on either side of Wailevu. Every tree within this belt was very severely attacked and many were killed. A colony of beetles was liberated in August, 1928, at Wailevu in the hope of effecting a control. In March, 1929 (i.e. only six months later), they were found to have spread throughout the infected area, and except at the extremities of the belt were, or had been, present on every tree. A very noticeable feature of their activities is that they destroy all the scale as they advance. For instance, all the scale has been completely destroyed for a distance of one mile from Wailevu, and the beetles are now scarce within this mile, since there is very little for them to eat. In the second mile, however, the beetles are present in hundreds on every tree and the scale is rapidly becoming less abundant. Their larvæ, which bear long white waxy tufts, are so numerous that they give the undersides of the leaves a whitish appearance, and their pupæ, which are usually massed together at the bases of the leaf-stems, form conspicuous white patches, six inches (and sometimes more) in diameter, which can easily be seen on tall trees from the ground. In the third mile scale is still plentiful and beetles are only to be found here and there. The rate of spread in this neighbourhood is not so great as elsewhere because the quantity of scale present was much greater, but the progress made is very satisfactory. By the end of 1929 there will, in all probability, be none left there.

The most striking instance of the general efficiency of the beetles as controlling factors occurred in the Savusavu district, along the coast from Savusavu to Nagigi. The scale was prevalent at intervals all along this coast and caused much damage. Two colonies of beetles were liberated in May and August, 1928, at Naidi. Within eight months they had spread of their own accord throughout the infected area which is about ten miles long, and had killed off all the pest in both directions as they advanced. In March, 1929, they were abundant at Nagigi (at the eastern end of the infected area) and at Naseva (towards the western end), though at all intermediate points they were rare, having no food left. The distance from Naidi to Nagigi is about seven miles. In many places on this coast there are considerable areas of dense bush which separate scale-infected patches of coconuts. There is little or no scale in these forest areas and the diseased belt is therefore by no means continuous. This discontinuity, however,

has in no way affected the rate of spread of the beetle, which is evidently capable of flying a considerable distance (at least a mile) in its search for food.

An excellent example of the thoroughness of the work of the beetle was found on Major Willoughby Tottenham's estate at Devadara. A small coconut palm, about ten feet high, has a little scale on one leaf only. There was none on any of the other trees within a quarter of a mile in any direction. Nevertheless, the beetles found this leaf and three adults were seen feeding on the scale on it.

Savusavu Bay is bounded on its eastern side by a long, hilly, peninsula which extends in a south-westerly direction and terminates at Savusavu Point. Naidi, where the beetles were originally liberated, is situated on the south coast of this peninsula about six miles from the point. A small outbreak of scale occurred at Daku which is on the north coast of the peninsula. The beetles discovered this outbreak within nine months of the date of their original liberation, and whether they travelled over the hills or round the point, the feat is a very remarkable one. There is no scale in the hills and the probability is that they followed the coast round the point. The distance from Naidi to Daku, via the point, is about ten miles.

The references which have been made to the distances covered by the beetles must not be interpreted as meaning the distances which single individuals are capable of flying. What is meant is that successive generations move on in search of food. The rate of multiplication is enormous, and the demand for scale therefore increases rapidly. The life-cycle from egg to adult occupies about $3\frac{1}{2}$ weeks, and experiments conducted on Ovalau have shown that each female beetle lays about 120 eggs per month, provided an abundant supply of food is available. Hence, if 10 female beetles were liberated in a certain locality at the beginning of March, for instance, at least 1,200 adult beetles would be produced during April. About 600 of these will be females, and therefore about 72,000 will be produced in May, and so it goes on. It is easy to understand from this why the beetles clear up the scale so rapidly in any one locality and why it becomes necessary for them to spread so far in search of food.

Wainunu and Savusavu have been specially mentioned in this report because they have been inspected more thoroughly than other districts. Brief inspections of other localities have, however, been possible from time to time, notably on the islands of Gau, Wakaya, and Ovalau, and have been sufficient to show that equally satisfactory results can be expected on all islands where scale was formerly a severe pest.

This very satisfactory position is due almost entirely to the small Coccinellid beetle, *Cryptognatha nodiceps*, Mshl. Of the four other species imported from Trinidad at the same time, two appear to be established in Fiji but are not playing an appreciable part in the control of the disease.

Despite the success obtained to date, which has surpassed all expectations, it is still necessary to be cautious in referring to the prospects for the future. It is the object of the Coconut Committee to effect an absolutely permanent control of the scale in Fiji, and it can certainly be said that there is every prospect of this object being attained, but it is necessary to wait at least two more years before any final conclusions can be drawn.

INTRODUCTION OF NATURAL ENEMIES AGAINST THE HOUSE FLY IN FIJI.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

IN our last issue the introduction into Fiji of *Spalangia cameroni*, a parasite of house fly puparia was recorded. Approximately 10,000 of these insects have now been bred and liberated, mostly within the Suva district, but colonies have also been placed at Rewa and Tailevu.

We are again indebted to our Hawaiian colleagues for another insect to be used in our efforts to reduce the pest. This is a dung burying beetle *Copris incertus* var *prociduus* Say, a strong colony of which, numbering 623, arrived by the last mail boat. Some 615 were liberated near Suva and it is much hoped that they will establish themselves and become sufficiently numerous to, by burying and breaking up the cow droppings in the paddocks, reduce the amount of this material available in a suitable condition as a medium for fly maggots to live in.

EXPERIMENTS WITH HOUSE FLIES IN FIJI.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

DURING the wet or summer season, house flies, in certain parts of Fiji, become exceedingly numerous and this has now been shown to be due to the fact that, at that season of the year, they are able to breed up in great numbers in cow droppings. With the advent of the cool season, which is generally, but not always, considerably drier, their numbers decrease to such an extent as to be almost negligible, although they still continue to oviposit freely in the droppings. It has been found, however, that the resulting maggots in most cases fail to reach maturity and marked droppings which were observed to carry a quantity of eggs, failed to show any larvæ when examined later. This mortality seems to take place in many cases, shortly after the eggs hatch and it was thought that it might be due to the lower temperature prevailing at this season, but the following experiments seem to indicate that this is not so.

FIJIAN COOL SEASON TEMPERATURE.

Fijian cool season temperatures frequently drop to about 65° F. at night with a diurnal maximum averaging about 79° F. Occasionally at night it drops to as low as 60° F.

TEMPERATURES OF DROPPINGS.

Efforts were made to ascertain how far fermentation raised the temperature of the droppings above that of the atmospheric shade. It was found that as a rule, this rise only took place during the first five days and was never more than 3° F. above the diurnal shade temperature.

LABORATORY EXPERIMENTS.

First Experiment.—A number of fly ova were collected and placed upon fresh cow dung in glass jars. These were kept at normal temperature in the office. The eggs hatched in due course and the maggots developed normally, producing adults in a minimum of 15 days, with an average of 16.55 for 140 individuals.

During this period the temperatures were: mean maximum, 79.76° F.; actual maximum, 84° F.; mean minimum, 69.11° F.; actual minimum, 65° F.

This compares with 11 days as a minimum egg to adult with an average of about 12 days obtained under similar conditions in summer, when the temperature stood at: mean maximum, 87.5° F.; actual maximum, 91° F.; mean minimum, 76.16° F.; actual minimum, 74° F.

The average being thus 7.39° lower than in summer with a lengthening of the life cycle by about 4½ days.

Second Experiment.—In the next experiment similar preparations were made, but the jars were placed in an incubator and kept at a uniform temperature of 68° F., a total variation of less than 1° being maintained. During the first five days the dung had risen to a temperature of a little less than 2° F. above that of the incubator falling again by the sixth day to the 68° of the incubator and, remaining thus until the end of the experiment.

The temperature of this incubator was below the mean winter minimum of Suva, yet despite this the fly eggs hatched and the maggots went through to maturity taking 17 days for the earliest individual and an average of 26.14 for the batch of 61 specimens.

The experiment was repeated with similar results, the bulk of the individuals taking 21 to 24 or 25 days from egg to adult.

Third Experiment.—In this experiment an effort was made to test the result of lowering the temperature considerably below the Suva minimum, using an ice box. There was a good deal of variation and on two occasions the ice ran out, occasioning a rise to 65° F. Normally, however, it stood between 55° F. and 62° F. with a mean maximum of 58.4° and a mean minimum of 57.25° F.

In this case it was found that the dung temperature was proportionally higher and varied far more than in the former tests, maintaining an average of 5.8° F. above that of the ice box, or approximately 63.6 F.

At this temperature, whilst there was considerable mortality and only some 20 flies reached maturity, the life cycle being extended to 30 to 34 days.

SUMMARY.

These experiments seem to show that the lower temperatures of the winter season are not the direct factor leading to the reduction in the numbers of this pest.

Field observations have also shown that, the prolonging of the life cycle, is not in itself the factor, as marked droppings were found to be sufficiently moist when 14 days old for the development of maggots, whilst the bulk of these disappeared long prior to this.

CONTAGIOUS OPHTHALMIA IN SHEEP.

By H. M. STUCHBERY, B.V.Sc.

AN outbreak of contagious ophthalmia has recently occurred in a flock of sheep in Fiji. This disease manifests itself as a conjunctivitis and keratitis, sometimes of one eye, but generally of both. It occurs in most domestic animals, but chiefly in ruminants, assuming epidemic proportions most frequently in sheep, doubtless on account of their gregarious habits. It is definitely contagious, but the casual agent has not been actually isolated. Pyogenic bacteria have been found in the lesions, but these organisms, when isolated, will not cause the characteristic symptoms of the

disease and their presence in the lesions is regarded as a secondary invasion. A specific organism causing periodic ophthalmia in horses, has been isolated in America, but it is doubtful if the two diseases are identical.

The origin of the outbreak under review is somewhat obscure. There were two recent importations into the flock, these being two rams from Australia. At the time the flock was examined by the writer these two animals showed no signs of eye trouble or ill-health of any kind. It is quite possible that they may have recovered from the disease, and were still acting as carriers of the casual organisms, or they may even have been acting as carriers without having had the disease themselves.

In this outbreak, the first symptoms were an inflammatory condition of the conjunctiva of the upper eyelid, accompanied by lachrymation. This inflammatory process gradually spread, in a descending fashion, over the whole external surface of the eye and conjunctiva. The conjunctiva was at first slightly infected, later becoming deep red and somewhat swollen. The sclera, or white of the eye, showed increase in the number and size of the blood-vessels, with consequent reddening. The cornea, or pigmented portion of the eye, first showed a bluish-white cloudiness, which became increasingly dense until, in the majority of cases, the cornea appeared quite opaque. In many cases, ulceration of the cornea was also present. Accompanying these symptoms there was a considerable purulent discharge from the eyes, and the animals evinced signs of severe pain. In all cases, the vision was affected to a greater or less extent. Where the opacity of the cornea was complete, the animals were totally blind. When this disease is neglected blindness may be permanent, due either to complete ulceration of cornea with extravasation of the contents of the anterior chamber of the eye, or to permanent opacity of the cornea.

When attention was first drawn to this outbreak there were about fifty animals affected, with seven cases of total blindness. As the disease had been in progress some time, it seemed probable that a number of animals not yet showing symptoms were already infected.

The first step in the treatment was the separation of the affected animals from those apparently healthy. Instructions were given that a strict watch be kept over the latter for the detection of fresh cases.

A lotion of zinc sulphate 2 per cent. and boric acid 1 per cent. in water was first used for treatment of the symptoms. This gave satisfaction in the majority of cases, but some did not respond as well as was expected. For these, a solution of silver nitrate 2 per cent. in water was used and this lotion was found to give more satisfactory results. It was intended to treat the patients twice a day, but owing to the numbers, treatment could only be performed once daily, except the severe cases, where two applications were made.

As expected the disease continued to spread through the remainder of the flock, until practically every animal had contracted it. As many as twenty totally blind cases were noticed at one time. Several sheep were lost through falling into waterholes. These were the only fatalities. The writer was unable to follow the progress of the disease to the completion of the outbreak, owing to having to leave the district, but advice from the owner shows that it has now been cleared up.

As far as can be determined this is the first recorded outbreak in the Colony. It is also the most severe attack the writer has experienced, both in point of severity of symptoms and percentage of affected animals. Out-

breaks in Australia have come under our observation where the percentage of infection has been 40 to 50, but the usual would be in the vicinity of 10 per cent. The probable explanation of this is that these sheep have never before been exposed to an infection of this kind, and their resistance was consequently less than that of animals where the disease is more common. It is a recognised fact that a primary outbreak of a disease in a country new to it, is always more severe in effect, both in point of numbers attacked and symptoms manifested, than those outbreaks in which the disease has been of fairly long standing duration.

It must be remembered that this disease, or one very closely allied to it, will attack cattle and goats as well as sheep. The symptoms in these animals are similar. The treatment used in the previous cases, viz.: 2 per cent. solution of zinc sulphate, or 2 per cent. of silver nitrate, in water, is equally effective in other animals, the silver nitrate treatment being probably somewhat more efficient, although liable to deterioration, particularly in the presence of light. To prevent the spread of the disease to other animals, the segregation of the affected ones should be carried out immediately the disease is detected, and the prescribed treatment started as soon as possible.

A NOTE ON FOWL POX.

By CHAS. R. TURBET, B.V.Sc., Senior Government Veterinary Officer.

MANY people consider that the disease of chickens often seen in the vicinity of Suva and elsewhere in Fiji, and known as chicken-pox or contagious epithelioma is the direct result of the irritation caused by mosquito bites. This, however, is not so, the disease being one which is caused by the infection with the virus of chicken-pox, similar in character to that of human pox or cow-pox.

It has now been recorded by Klighter, Muckenfuss and Rivers ("Transmission of Fowl Pox by Mosquitoes") *The Journal of Experimental Medicine*, Vol. XLIX, No. 4, page 649, that fowl pox can be definitely transmitted from infected to non-infected non-immune birds by the bites of mosquitoes which have previously fed on infected birds.

The authors of the above mentioned Article record a number of experiments in which two different varieties of mosquitoes were first allowed to feed on the combs of infected chickens and then again upon healthy birds.

It was shown that both *Culex* and *Aedes* mosquitoes are capable of transmitting the disease from one bird to another. It was also found that the mosquitoes remain capable of carrying infection for at least 14 days following a meal on a diseased fowl, and this must therefore be taken into consideration in any scheme for the control of the disease.

It is now considered that immunisation of chicken offers the best method of controlling losses. Combined with that, however, general mosquito control should be undertaken by the community, whilst, where possible, chickens should be housed by night in mosquito proof houses. Curative treatment consists of supplying water containing potassium iodide, plucking the nodules and painting the affected area with a mixture of equal parts of tincture of iodine, Friar's balsam and glycerin.

Owners should get into touch with the Veterinary Division of the Department of Agriculture whenever an outbreak occurs in their poultry run.

KAPOK.

(Reprinted from the *Bulletin of the Imperial Institute*,
Vol. XXIV, No. 1, 1926.

A SURVEY OF ITS PRODUCTION WITHIN THE EMPIRE, WITH NOTES ON ITS
CULTIVATION AND USES.

THE fine, cotton-like fibre known as kapok is now familiar to everyone from its widespread use as a stuffing material in upholstery. The tree which produces it occurs in all the tropical parts of the British Empire, but practically the entire commercial supply of the fibre is obtained from Java. Efforts have been made at different times to start an export trade in kapok from various British countries, but hitherto the only success obtained, and that on a relatively small scale, has been in Ceylon. The Agricultural Department in Malaya has recently taken up the matter energetically, and there seems every reason to expect that commercial supplies will eventually become available from that country. India exports a certain amount of floss under the name kapok, but this, as will be shown later, is principally derived from a different tree from that furnishing Java kapok and is inferior to the latter in quality. Among foreign countries, other than Java, there is a small export of true kapok from the Philippines and Indo-China. In these countries, and also in Siam, the extended cultivation of the tree is being advocated. A certain amount of floss, of diverse origin, is also shipped from South America.

In view of the interest at present being shown in the material, it has been considered opportune to publish the present article dealing with the prospects of kapok production within the Empire, whilst for the benefit of those desiring to grow the tree for the production of the fibre, information has been given as to methods of cultivation and preparation. Specimens of kapok produced in many countries of the Empire may be inspected at the Imperial Institute by those interested.

As indicating the existing demand for kapok, it may be mentioned that in 1924 Java and Madura exported over 15,000 tons, of a total value exceeding 1½ million pounds sterling. Of this quantity nearly 8,000 tons was shipped to the United States; the Netherlands and Australia each took about 3,000 tons and New Zealand and the United Kingdom 500 and 400 tons respectively. There was also in that year an export of about 1,000 tons from the Outer Possessions of the Dutch East Indies, the bulk of which was consigned to the Netherlands. The imports of kapok into the United Kingdom during recent years are shown in the following table:—

From	1922.		1923.		1924.	
	Tons.	£	Tons.	£	Tons.	£
India	355	24,578	566	52,486	333	31,783
Other British Possessions ..	103	7,544	95	10,521	108	9,174
Netherlands	78	7,911	30	3,421	53	7,173
Java	362	36,826	558	69,608	358	44,235
Indo-China .....	..	32	..	....	113	12,616
Other Foreign Countries ..	5	470	90	4,697	36	2,617
Total Imports	903	77,361	1,339	140,733	1,001	107,598
Total retained in the United Kingdom	711	58,954	1,113	115,839	690	74,505

The quantities of Indian kapok retained in this country during the three years were 256, 449 and 250 tons respectively. The corresponding figures for Java kapok were 302, 473 and 288 tons.

In considering the question of extending the production of kapok within the Empire, it is important to bear in mind the possible effect on prices of a large increase in the supplies. In this connection the Imperial Institute is informed by a large firm of kapok merchants that the demand for kapok is increasing, especially in the United States and in certain of the British Dominions, and is likely to continue to do so. They consider that it would be desirable to further the production of the floss within the Empire. Similar views were expressed by an important firm of kapok brokers. As regards the United States it has been stated that mattress manufacturers in that country cannot "boom" kapok, owing to the difficulty of obtaining supplies. On the whole, therefore, it seems probable that, provided properly prepared material equal to or approaching the Java product in quality can be supplied within the Empire, there should be no difficulty in finding a market for it at good prices.

Before the war the market price of Java kapok in London was about 7d. to 9d. per lb. Towards the close of the war the price had risen to as much as 1s. 9d. It has since fallen somewhat and prime Java kapok is now quoted at 1s. 3½d. per lb.

SOURCES AND USES OF KAPOK.

In a large number of plants belonging to widely different families the ripe fruits contain a mass of fine hairs, sometimes attached to the seeds, as in the case of cotton, or arising from the wall of the capsule, as in kapok. These hairs are intended by nature to aid in the distribution of the seeds, but man has adopted them in some cases for his own use. In the most notable of these, cotton, it has been possible by hybridisation, selection and suitable cultivation to produce material which in length, colour, yield and other properties shows a vast improvement over the wild forms. The group of fibres to which kapok belongs, known collectively as flosses or silk-cottons, are usually finer than cotton and exhibit a greater lustre, but they are much weaker than cotton and lack the twist which enables the latter to be spun. Their use, therefore, has hitherto been restricted, and apart from the careful cultivation and preparation of true kapok little has been done to improve their quality.

The term "kapok" has been used for the product of a number of trees, but it should be restricted to the floss of *Eriodendron anfractuosum* (= *E. orientale*, *Ceiba pentandra*), the source of Java kapok. This tree, which belongs to the natural order Bombacaceæ, reaches a great size under natural conditions, but in cultivation is usually seen as a slender tree not exceeding 50 ft. in height. It has a very characteristic appearance, producing horizontal branches arranged in tiers. It sheds its leaves in the dry season; the flowers appear just before or at the same time as the new leaves. The fruit is a more or less oblong capsule or pod, about 6 in. long and 2 in. in diameter at its greatest width. As already mentioned the hairs spring from the inner wall of the capsule and are not attached to the seed itself, as in the case of cotton. This is of some importance in connection with the commercial preparation of the floss, as it renders the separation of the seed much more easy, the hairs not having to be forcibly removed from the seed as is necessary in the ginning of cotton.

Flosses allied to true kapok are yielded by many other plants of the Bombacaceæ, the chief of which are species of *Bombax*. The floss exported from India is mainly derived from *B. malabaricum*, and this, when properly prepared, is of good quality, but is not so resilient as good Java kapok. Several species of the genus occur in West Africa, where their floss is used locally, the chief of these, perhaps, being *B. buonopozense*. Other members of the family yielding flosses include *B. Ceiba* and *Chorisia* spp. of South America, *Eriodendron samauma* of Brazil and *Ochroma lagopus* of tropical America and the West Indies. Amongst other plants producing silk cottons may be mentioned species of *Asclepias*, *Calotropis gigantea*, *C. procera* and *Gomphocarpus brasiliensis* belonging to the Asclepiadaceæ, *Cochlospermum gossypium* (Bixaceæ) and the West African rubber tree, *Funtumia elastica* (Apocynaceæ). All these flosses are inferior to true kapok and are unlikely to compete with it in European markets.

The hairs of kapok are cylindrical, from 0.6 to 1.2 in. in length, with very thin cell walls. The cells are full of air and are very light; they also possess the property of being impermeable to moisture, and on this account are extremely buoyant. For this reason kapok is now used throughout the world for the manufacture of buoys, life-belts and life-saving jackets.

The chief use for kapok is for stuffing cushions, pillows, mattresses and similar articles. It is well adapted for this purpose on account of its lightness, its springy or resilient nature and its non-hygroscopic and non-absorbent characters. It is in their resiliency that most other flosses are inferior to kapok and therefore of less value for stuffing purposes.

Many attempts have been made to employ kapok as a textile material, but considerable difficulty has been experienced due chiefly to the fact that the fibres have a smooth, slippery surface and, therefore, lack cohesive force. Moreover, kapok is very weak, and yarns made from it are not strong enough for use where any strain is likely to occur. It is stated that the difficulty of spinning the fibre has been surmounted by roughening the surface by chemical treatment, and so enabling it to exert the necessary grip. By a special arrangement and adaptation of the spinning machinery the roughened fibres can be spun either alone or in admixture with cotton. The yarns so produced are said to be suitable for the manufacture of plushes, lace and other materials. Kapok textiles cannot possess such good wearing properties as those made of cotton, but owing to their non-conducting character they might find a special use as an interlining in warm clothing.

KAPOK SEED.

In the course of preparing kapok for the market large quantities of seed are obtained. The seed is rich in oil, and in many countries where the floss is prepared for local use the oil is expressed from the seeds and employed for cooking and other purposes. In the Dutch East Indies the seed now forms an important source of revenue; in 1924 about 14,000 tons, valued at £97,500 were exported from Java and Madura, of which all but 1,000 tons were consigned to the United Kingdom.

Samples of kapok seed from Travancore, the Federated Malay States, Gold Coast and Zanzibar have been examined at the Imperial Institute. The results are shown in the following table, which includes for comparison the figures for Java kapok seed and oil and for cotton seed and oil.

It will be seen that in general characters the oil resembles cotton-seed oil. After refining it can be employed as an edible oil, and it is also suitable for soap-making and other purposes to which cotton-seed oil is applied. There

Kapok Seed and Oil.							Cotton Seed and Oil.
	Travancore.	Federated Malay States.		Gold Coast.	Zanzibar.	Usual Range.	Usual Range.
<i>Seed.</i>							
Moisture, per cent. . .	11·4	I. 13·8	II. 12·9	13·2	12·7	...	...
Yield of oil, per cent. .	24·3	20·0	18·8	24·7	21·0	22-25	20-24
Yield of oil (moisture free seeds) p. c. . .	27·4	23·2	21·6	28·4	24·0	...	...
<i>Oil.</i>							
Specific gravity at 15°/15° C.	0·9217	..	..	0·9226	0·914	0·921-0·933	0·922-0·925
Acid value	30·9	54·1	61·0	6·1	26·0	variable	variable
Saponification value	192·2	..	..	193·5	194·2	189-195	192-195
Iodine value (Hubl, 17 hours) per cent.	90·4	..	..	89·6	101·5	85-94	105-115
Unsaponifiable matter, per cent.	1·2	..	..	..	..	...	0·8-1·8
Refractive index at 40° C.	1·463	..	..	..	..	1·4605-1·4657	1·4646-1·4653
Solidifying point of fatty acids	29·8° C.	..	..	..	..	27-32° C.	33-37° C.

is a steady market in the United Kingdom for kapok seed, and a small consignment received at the Imperial Institute from the Federated Malay States was sold in Liverpool in March 1925 at the rate ruling for Java kapok seed, viz., £11 15s. per ton, c.i.f. As regards the marketing of the seed the Institute is informed that it is the custom in this country to allow 25 per cent. of damaged seed in a consignment without any reduction being made in the price, notwithstanding the fact that the seed obtained from kapok plantations in Java contains, as a rule, only a little over 4 per cent. of defective seed.

The residual cake, left after the expression of the oil, forms a fairly good feeding-stuff for live-stock; it is somewhat inferior to cotton-seed cake, and is believed to be used principally as an ingredient in compound feeding-cakes. The composition of the meal obtained from Travancore seed at the Imperial Institute is shown in the following table, in comparison with commercial kapok-seed and undecorticated cotton-seed cake.

	Kapok meal from Travancore seed.		Commercial kapok-seed cake.*	Undecorticated cotton-seed cake English make.*
	As prepared at the Imperial Institute.	Calculated to contain 7 per cent. of fat.		
	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	33·8	12·9	13·8	13·8
Crude proteins	32·7	30·6	26·2	24·6
Fat	0·5	7·0	7·5	6·5
Carbohydrates, &c., (by difference)	19·8	18·4	23·2	29·3
Crude fibre	26·8	25·1	23·2	21·2
Ash	6·4	6·0	6·1	4·6
Nutrient ratio	1:0·6	1:1·1	1:1·5	1:1·67
Food units	103	112	107	107

* Smetham, *Journ. Roy. Lancs. Agric. Soc.*, 1914.

The cake is rich in constituents of manurial value, the percentage (expressed on dry matter) in the case of cake prepared in Indo-China being as follows:

Nitrogen	..	..	..	4.5
Phosphoric Acid (P_2O_5)	..	..	..	1.6
Potash (K_2O)	..	..	..	1.5

Indian kapok seed (*Bombax malabaricum*) yields an oil similar to that obtained from true kapok seed, but of slightly better quality (see this Bulletin, 1920, 18, 335). The residual cake is rich in proteins and would form a more valuable feeding-stuff than kapok seed cake.

OTHER BY-PRODUCTS.

The wood of the true kapok tree is light and soft and little used, even by the natives. It has been suggested that the wood might be suitable for paper-making, but experiments conducted some years ago by a firm of paper manufacturers in this country were not very satisfactory, and it was not considered that the production of pulp from the material would be a commercial success. More recent experiments in France showed that the wood yields 30 per cent. of bleached pulp (expressed on the dry material), which furnishes a paper of ordinary quality.

The young leaves and the roots are used in native medicine, whilst the bark contains a reddish-coloured fibre sometimes used by the natives for tying purposes.

PRODUCTION OF KAPOK IN THE EMPIRE.

Asia.

True kapok grows in the hot moist tracts of Western and South India and in Burma, but it is nowhere systematically planted. The internal trade in the floss is stated to have developed considerably, but the quantity shipped is small, most of the so-called kapok exported from India consisting as already mentioned, principally of the floss of *Bombax malabaricum*. So far as can be judged from material examined at the Imperial Institute, the true kapok produced in India is of good quality. A sample from Madras examined in 1906 was considered by brokers to be fully equal to good Java kapok and a sample from Travancore recently received at the Institute was also favourably reported on.

The exports of Indian kapok, chiefly from Bengal and Bombay, in 1923-4 amounted to 1,692 tons, of total value of £136,000. Of this quantity 448 tons were shipped to the United Kingdom, 272 tons to the Netherlands, 210 tons to Germany, 196 tons to France, 140 tons to Italy, 110 tons to the United States and 73 tons to Australia.

Two grades of Indian kapok are recognised on the London market, viz., Calcutta and Bombay. Double-cleaned Calcutta kapok was recently quoted at 1s. to 1s. 0½d. per lb, or 3d. less than prime Java.

Eriodendron is a common tree in Ceylon and is widely distributed. It grows from sea-level to 2,500 ft. or more, but gives the best results at low and intermediate elevations. It is planted in village gardens and on some estates as a boundary tree. There is a small export of kapok from the island, the quantity in recent years amounting to about 300 tons, most of which has been consigned to the Netherlands. The quality is usually intermediate between Indian and Java kapok.

In parts of Malaya the kapok tree is grown in considerable numbers by the peasants, but hitherto little use has been made of the product except for domestic purposes. The Agricultural Department have recently made

an exhaustive study of the possibility of establishing an export trade and have initiated a scheme for collecting the pods from existing trees and selling the floss and seed. Further, they definitely assert that Malaya is suitable for the profitable production of kapok under plantation conditions.

It is estimated that at the present time there are about 100,000 trees in Malaya, of which 7,500 are in Selangor (mainly in Kuala Selangor); 3,800 are scattered in Pahang; 62,000 are in Perak (of which 40,000 are near Perak River and 20,000 in Krian); 7,000 are scattered in Malacca; and 6,100 are in Penang (4,000 of which are in Balik Pulau). Of the trees now now in bearing nearly three-quarters are to be found in the four definite workable areas mentioned in brackets above. It is in these districts that endeavours will be made to teach the Malays to harvest the pods and prepare the floss for the market. Collecting centres will be established at which kapok brought in by the natives will be purchased for cash. In certain districts arrangements have already been made, under European management, for the purchase of kapok and its preparation for the market.

Kapok of fairly good quality has been produced in Mauritius, but, owing to the ravages of a beetle, the cultivation of the tree had to be given up (see page 60). A sample of floss from trees grown at the Botanic Gardens, Pamplemousses, was examined at the Imperial Institute in 1906. It was slightly darker than ordinary Java kapok, more uneven in colour and somewhat inferior in lustre. Similar material would find a market in this country at prices a little below that of the Java product.

Africa.

The kapok tree reaches a very large size in the West African forests, being only exceeded by a few mahoganies. It occurs in all the British Colonies of West Africa and is found in both the evergreen and mixed deciduous forests. No systematic attempt seems to have been made to collect the floss, except in Togoland. Here kapok received special attention under the German régime and seed was distributed in large quantities to the natives. The tree occurs throughout the whole of the Mangu-Jendi District in Northern Togoland, part of which is now included within the British sphere, but it is considered that the establishment of any extensive export trade from this district would have to await the provision of railway transport. Before the war there was a small export from Togoland, 9 tons being shipped in 1913. This is stated to have been derived mainly from wild trees. A small bale of kapok from Togoland was received at the Imperial Institute from the Chief Commissioner, Northern Territories, Gold Coast, in 1916. It was similar in all respects to the kapok of commerce and was sold at a satisfactory price, considering the small quantity available. It would certainly be worth while to encourage the natives to collect and clean the material for export, both in this district and in other parts of British West Africa. It will be necessary, however, to insist on the systematic picking of the pods in order to maintain the quality of the floss, and not to allow the natives merely to gather the fallen pods, as they at present do for their own use. The results of examination of material received in recent years at the Institute from the Gold Coast and Gambia indicate that kapok of good quality could be produced in those countries if due care were taken in the preparation.

In East Africa the systematic cultivation of kapok has been undertaken in Tanganyika. Before the war the industry was increasing, the area under cultivation in 1910, 1911 and 1912 being 1,735, 3,458 and 6,580 acres res-

pectively, and the exports in those years being 12, 28 and 52 tons. No information appears to be available as to the present area under kapok in the Territory, but it has been stated that the plantations suffered damage by elephants, both during and since the war. There are signs, however, that the industry is reviving, and during the four years ending 1924, quantities of 6, 30, 32 and 52 tons respectively were exported. The local Department of Agriculture do not seem to favour any extension of the cultivation, as the kapok trees are liable to harbour insect pests which may spread to the cotton-fields.

Kapok is stated to grow well in the coastal region of Kenya, and it is planted commonly as a boundary tree in Zanzibar. Floss produced in Government plantations in the latter country is stated to have been exported to the United Kingdom.

The tree thrives well in the Sudan, and floss obtained from trees planted at Mongalla was examined at the Imperial Institute in 1917. It proved to be of excellent quality, and similar material, if produced in commercial quantity, should realise the market price of good Java kapok.

West Indies.

The kapok tree is found in most of the West Indian islands; one, at Nassau, Bahamas, has reached a very large size and is familiar to all visitors to that island. There seems little hope, however, of the floss from existing trees in the West Indies being collected for export, owing to their very scattered distribution. Moreover, it is unlikely that the tree will be planted specially for the production of floss, on account of its harbouring a cotton stainer; indeed, for this reason it has been made compulsory in St. Vincent that all kapok trees should be destroyed.

An attempt was made some years ago to introduce the cultivation of the tree into British Guiana, and a number of plants were raised for distribution but no development appears to have been recorded.

Australasia.

The tropical parts of Australia seem suitable for the cultivation of kapok, and a few trees already exist round some of the towns in Northern Queensland. The Agricultural Department in Queensland have drawn attention to the possibility of producing the floss for the Australian market, at present supplied by Java, and point out that the tree can be grown practically along the whole of the Queensland coastal belt from Brisbane northwards. They suggest that the most profitable method in that area would probably be to plant the trees as wind-breaks or shade trees, rather than in the form of pure plantations.

In New Guinea, under the German régime, kapok trees were regularly planted for several years and the crop was collected and exported. The produce was of good quality and realised satisfactory prices, but the cultivation was stated to be unprofitable, chiefly on account of the high cost of transport, and was, therefore, abandoned.

The kapok tree is cultivated by natives in all parts of North Borneo, but the industry has made little progress, as the floss has mostly been shipped in the uncleaned state. The cleaned floss, however, is of excellent quality, and has been sold in the London market at the price of the best Java kapok. In 1919 a concession was granted to a London company giving them the sole right to export kapok from the territory, and in return they agreed to purchase at a fixed minimum price all kapok offered to them. The com-

pany also undertook to install cleaning machinery and to export a minimum quantity of cleaned floss per annum. In the event of the supply of kapok being insufficient the company will themselves undertake planting operations. During the first year (up to July, 1920), the company had purchased from producers 38 tons of kapok, most of which was shipped to London, and small quantities have continued to be exported each year since.

Attention is also being devoted to kapok in Samoa. The tree grows practically wild throughout the islands, and is at present chiefly used as a wind-break in cocoa plantations.

CULTIVATION.

Climate.

A suitable climate is the first essential to the successful cultivation of the kapok tree. Although found in a wild or semi-wild state from the sea-level up to an altitude of 3,000 or even 4,000 ft. and more, the tree gives the best yield and quality of fibre when grown at elevations less than 1,500 ft. above the sea. It will withstand slight frost, but low temperatures hinder the growth of the tree and the development of the fibre, and from a commercial point of view cultivation should be attempted only in the tropics or in certain parts of semi-tropical countries. As regards rainfall, the tree flourishes under a wide range of conditions. It reaches its greatest size in the tropical rain forests of West Africa, but at the same time owing to its deciduous habit, it can resist long periods of drought. The ideal conditions are abundant rain during the growing season and a dry period from the time the flowers are setting until the pods are harvested. As in the case of cotton, a long spell of wet or even damp weather during the later stages of pod formation will greatly reduce the quality of the fibre.

The quick growing branches are easily broken or damaged by high winds, and exposed situations should therefore be avoided in fixing the site of plantations.

Soil.

A well-drained soil is necessary for the proper growth of kapok. It flourishes well on a deep, porous, sandy loam, such as is frequently found on alluvial flats along streams, but the finest kinds of Java kapok are produced on well-weathered volcanic soil. It is not always advisable to plant the better land exclusively with kapok, since this can often be more profitably used for other crops. Nevertheless, a soil of fairly high fertility is required since the returns from kapok are relatively low, and a high yield is therefore essential.

Land infested with white ants should not be used for kapok since the tree is very susceptible to the attack of these insects.

Propagation.

The tree is easily propagated from either seed or cuttings. The merits of the two methods have been a matter of dispute. Plants raised from cuttings come into bearing somewhat earlier, but, on the whole, the general opinion is in favour of propagation by seed. Advantages of the latter method are that a deep-growing tap-root develops which renders the plant less liable to be uprooted by high winds, and the plants remain longer in bearing. Where a form notable for its high yield or other specially favourable character is to be reproduced, cuttings should be employed.

Seed for sowing should, whenever possible, be specially obtained from the largest pods of old high-yielding trees, instead of using purchased seed

of unknown parentage produced in the course of cleaning the floss. About 6 lb of seed should be sufficient for planting up 100 acres. The seed is sown in nurseries, sometimes in rows 10 to 12 in. apart in raised beds, or, as recommended in the Philippines, in "hills" about 6 in. apart. The nursery must be carefully prepared, the soil manured beforehand, if poor, and kept well weeded. In dry weather watering may be necessary. As soon as the seed has germinated, which takes only a few days, the seedlings are shaded until they are about 5 or 6 in. high, when they must be exposed to the sun. If the plants do not obtain plenty of sunshine they grow thin and lanky. At this stage the seedlings should be thinned out to 6 or 9 in. apart; when sown in hills only one seedling should be allowed to each hill. The young plants grow very quickly, and when from 6 to 12 months old they should be planted in their permanent quarters.

Owing to the readiness with which kapok cuttings take root, this method of propagation has hitherto been that most commonly used by the natives of Ceylon and the Philippines. The cutting, which should never be of the current year's growth, varies in size from about $\frac{3}{4}$ to 2 in. or more in diameter and from 18 in. to 6 ft. or more in length. Experiments conducted in the Philippines with cuttings ranging in length from 1 to 10 ft. and $\frac{1}{2}$ to 5 in. in diameter at the base, showed that the larger cuttings gave the best results, 100 per cent. of those 6 ft. or more in length and $3\frac{1}{2}$ in. or more in diameter striking root, as against from 15 to 70 per cent. in the case of the smaller cuttings. The cuttings should be inserted as soon as they are cut, about 12 to 18 in. deep according to their size, and this work should be done, if possible, at the beginning of the rainy season. The cuttings must be inserted in the place they are to occupy permanently.

Planting Out and After-cultivation.

In Java, and indeed in most countries where the natives cultivate kapok, the trees are most commonly planted irregularly, as boundary trees and fences, along the sides of roads, or with other trees in the gardens. It is from such indiscriminately planted trees that most of the kapok produced is still obtained. In Java the tree is sometimes planted between other crops, such as coffee, cocoa, pepper and vanilla, whilst in the Philippines it has been suggested that fibre crops like maguey, sisal and mauritius hemp, might be interplanted with kapok. The most suitable crop to be grown in this way will vary with local conditions, and from observations made in Malaya it is thought that roselle fibre, sunn hemp, tuba, limes and tobacco should prove successful. In quite recent years the practice has been commenced in Java and the Philippines of growing kapok as the sole plantation crop; but this method will probably only give profitable results where the conditions are specially favourable to the production of high yields.

When grown as the only crop in plantations the seedlings or cuttings should be placed about 18 ft. apart, but in mixed plantations the distance will vary with the nature of the accompanying crops. The seedlings, when removed from the nursery, should be topped and all leaves removed. In lifting the plants, the roots must be damaged as little as possible, and planting out should be done immediately. If possible, transplanting should be performed during showery weather.

Little cultivation of the soil is required in kapok plantations. For a few months after planting the soil should be kept loose round the plants, and if kapok is the sole crop it is only necessary to keep the ground clean for a short distance from the tree to facilitate the collection of the pods. The remainder of the plantation is preferably planted with a leguminous cover crop, so that the cost of weeding is reduced to a minimum.

Harvesting and Yield.

Where, as in Java, the pods ripen during a dry season, they are often collected each day as they fall to the ground, but if rains are liable to occur during the harvesting period, the pods must be picked from the tree as they mature; otherwise the floss may suffer considerable damage. As the pods ripen their colour changes from a light green to a light brown and the surface, at first smooth, becomes somewhat wrinkled. It is at this stage, and before the pods open at the end, that they should be picked. It is no economy to harvest the whole crop at once, since this will result in a mixture of unripe, ripe and over-ripe pods, which will give a product of low value. The ease with which the branches break precludes the gathering of the pods from tall trees by climbing, and they are best gathered by means of knives or small hooks attached to long poles. The harvesting season usually extends over a period of about 3 months. The pods must be spread out on a dry floor in the sun to ripen thoroughly and the floss removed as soon as possible. If it is necessary to store the pods for a time, they must be thoroughly dried, so as to avoid fermentation and discolouration of the floss.

Kapok trees usually begin to bear after 3 or 4 years, but the yield at first is small. Seven-year old trees will yield 350 to 400 pods, and 10-year old trees 600 pods or more. The yield of cleaned floss from the pods varies somewhat, but on the average it may be taken that 100 pods furnish 1 lb of cleaned floss. On this basis an acre planted with 132 trees (18×18 ft.) would yield about 800 lb of floss.

Preparation of the Fibre.

Although machinery is now largely employed for cleaning kapok in Java, the initial process of opening the pods and removing the floss and seeds from the husk and core is always done by hand, chiefly by women and children. The subsequent separation of the floss from the seed is the most important process in its preparation. A common native method is to place a quantity of floss and seeds on a perforated platform and beat it with bamboo sticks, wielded in a horizontal direction, so that the seeds are loosened and fall through the holes in the platform. This is continued until the floss is beaten up into a snow-like mass. The top layer is then removed and given a further beating on another platform, when the floss is ready for baling. In an improved method, which has come into use in Java, the floss as it comes from the pods is placed in a bamboo basket or hollow cylinder with a perforated base, and the mass stirred up by a paddle-like arrangement revolved within it by means of a handle. These hand methods are only of use where kapok is produced on a comparatively small scale. On a large scale machine-cleaning is essential. Most of the machines hitherto employed consist of a horizontal chamber with a perforated bottom, in which the floss is beaten up by a series of blades revolving close to fixed blades on the sides of the chamber. The blades are so arranged that the floss moves along to the end of the chamber, where it is either blown out by fans or falls into receptacles. The Bley machine, invented by a Java planter, is claimed to be able to clean 217 kilos. of floss per hour. This could only be used profitably on a very large scale. A smaller machine, of British manufacture, capable of cleaning 120 to 130 kilos. of floss per day of 10 hours, has been used in the Philippines.

Kapok should always be graded carefully before baling for export. As a rule, four grades of cleaned Java kapok are recognised: (1) Superior or extra, containing less than 0.5 per cent. of seed; (2) prime, containing not more than 2 per cent. of seed; (3) fair average, with no more than $3\frac{1}{2}$ per cent. of seed; and (4) damaged.

Owing to the bulky nature of the material, the floss is pressed into bales for export. The pressure applied will depend on the size of the bale, but too much must be avoided, particularly with the finest quality, otherwise the elasticity of the fibre will be destroyed. Machine-cleaned, very dry fibre requires more pressure than hand-cleaned, but on the average the pressure should not exceed 140 lb per sq. in. Thus a bale 2 ft. wide by 2 ft. long will require a pressure of 80,640 lb. The bales are generally packed in gunny cloth or matting and are bound with galvanised iron hoops, cane, or fibre. The weight of the Java bales ranges from 80 to 120 lb and the size from 8 to 16 cubic ft.

Pests and Diseases.

So far few insect pests and fungoid diseases have been recorded as causing any great damage to the kapok tree or floss. This may be due to the custom, most frequently followed at present, of growing the tree in isolated positions. If large plantations are made it will be necessary to keep careful observation to prevent the spread of harmful insects and diseases, just as is the case with other plantation crops.

In Malaya and certain other countries white ants are the most serious pests, especially to young plants, and the usual precautions against these insects must be taken. An insect (*Dysdercus cingulatus*), allied to the cotton stainer, sometimes attacks the pods, but the damage is said to be slight. A related species has also been reported on kapok in San Thomé. It is sometimes considered inadvisable to grow kapok in the vicinity of cotton, owing to the danger of stainers spreading to the latter crop and, as already stated, in St. Vincent all kapok trees have to be destroyed. There is little risk, however, if the trees are properly tended and care is taken not to allow old pods to lie on the ground. In the Belgian Congo, kapok trees in the neighbourhood of cocoa plantations are cut down, owing to the fact that they serve as host-plants for a serious cocoa pest, *Sahlbergella singularis*. Caterpillars of several kinds of moths do a certain amount of damage, and one of them (*Mudaria variabilis*) in certain years has been known to destroy a large proportion of the crop in Java. In 1914, for example, it is recorded that 30 per cent. of the pods were attacked. The caterpillar feeds on the undeveloped fibre and seeds of the green pods, and even if any fibre should mature it is usually badly stained, whilst birds in their search for the caterpillars often complete the destruction of the pods. Other caterpillars bore into the stem and twigs, and some feed on the leaves. Boring beetles of the genus *Batocera* also attack the tree, and one of them (*B. rubra*) is so partial to it in Mauritius that kapok cultivation has had to be given up in that island.

Bats, monkeys and squirrels sometimes do considerable damage by eating the green pods or growing shoots.

Among the worst enemies of kapok in Java and Malaya are parasitic flowering plants of the genus *Loranthus*, which send out suckers into the bast and wood of the tree and absorb the nutriment required by the growing shoot. In bad cases the whole tree becomes weakened by the loss of the necessary nourishment and great damage may thus be caused. The trouble is not difficult to control if the plantation is properly inspected at regular intervals and all parasites removed as soon as they make their appearance.

Among the few fungoid pests of kapok, pink disease (*Corticium salmonicolor*) has been known to attack the plant, and leaf spot (*Ramularia eriodendri*) and an unidentified disease causing bleeding at the base of the trunk have occasionally been reported.

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Note by Editor.

For some further information on this subject we are indebted to Messrs. Burns Philp & Co. Ltd., through the courtesy of their Levuka Manager.

They inform us that seed selection in Java has been brought to a high pitch and such selected seeds are expensive, costing about £10 per cattie = 1½ lb English. Unselected seeds are crushed for oil and fetch from £5 to £8 per ton.

The bulk of the output in Java is still native grown but there are also a number of European owned estates.

The Editor would suggest that intending European planters should go carefully into the labour costs in Fiji. Labour in Java seldom costs more than 1s. per day and most of the sorting and separating the floss from the seed is done by women. (The Editor was informed when in Java that women earned about 9d. per day.) Machinery can be employed for part of this work and, under the much more expensive labour conditions in Fiji, would have to be used. It is also required for pressing the bales. It would be necessary to ascertain—

- (1) cost of this machinery;
- (2) necessary output to make machinery an economic proposition;
- (3) proportion of work of preparation which cannot be done by machinery and relative cost thereof.

SOME USEFUL FORMULAS.

No. 1.—LEAD ARSENATE.

Stomach poison for biting insects on plants.

Lead arsenate paste 2 to 3 lb to about 50 gallons of water.

No. 2.—AMERICAN-ARGENTINE ANT SYRUP.

Granulated sugar	12 lb
Water	11 parts.
Crystallised tartaric acid	7 grams.
Benzoate of soda	9 grams.

Boil slowly for half an hour; allow to cool.

Dissolve sodium arsenite (C.P.) $\frac{3}{4}$ oz. in $\frac{1}{2}$ pint of hot water. Cool, and add poison solution to syrup and stir well. Then add to the poisoned syrup 2 lb of strained honey and mix thoroughly.

NO. 3.—BORDEAUX MIXTURE.

(Average strength.)

For fungus diseases of plants.

Bluestone	16 lb
Quicklime	20 lb
Water	200 gallons.

Dissolve the bluestone and slake the lime in separate vats, the bluestone to be kept from contact with all metals except copper. Thoroughly mix the dissolved bluestone with one-half the water and the slaked lime with the other half. Run the two mixtures together in a single stream into the spray tank through a fine screen. For convenience, the mixing vats may be placed on an elevated platform, and the two parts mixed as they are flowing into the spray tank. The milk of lime should be continuously stirred during the mixing.

A somewhat less satisfactory Bordeaux mixture may be made as follows:—Slake the lime and dissolve the bluestone in separate barrels as above. Fill the spray tank half full of water; add the dissolved bluestone; strain in the slaked lime while the agitator is running; add remainder of water, and mix thoroughly.

NO. 4.—KEROSENE EMULSION.

Contact poison for sucking insects on plants.

This is one of the most useful of all the contact insecticides for spraying plants against scale insects, mealy-bug and all related insects. The difficulty of getting a true emulsion with the water which is available in many localities has proved an objection to its use, but with care and by the use of rain-water, an emulsion ought to be obtained.

Kerosene emulsion is made from—

Hard soap	$\frac{1}{2}$ lb
Kerosene	2 gall.

Dissolve the soap in 1 gallon of water by boiling. Remove from the fire and immediately add 2 gallons of kerosene and churn violently with a syringe or force pump until the mixture becomes creamy, and the oil is all held by the soap. This is the stock solution, and is sufficient for 33 gallons of wash. Great care should be taken to get a perfect emulsion as any free oil is likely to injure the plants. If any considerable layer of oil is observed on the surface of the stock solution when it has stood for 24 hours or more, the emulsion is not perfect. If difficulty is experienced in this respect, an increase of the amount of soap will often aid in producing the emulsion.

The above formulas Nos. 1, 2 and 3 are from Circular No. 265, College of Agriculture, University of California.

No. 4 is from *Insect Pests of the lesser Antilles*, by H. A. Ballou.

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 2.]

THIRD QUARTER, 1929.

[No. 3.]

EDITORIAL.

IN this, the first issue of the *Journal* to be issued under my Editorship, it is perhaps meet and proper that I should tender a note of greeting to readers, and indeed to all those interested directly or indirectly in agricultural pursuits in the Colony of Fiji. To most of you I am still a stranger enveloped in a more or less mysterious veil, to some a signature of doubtful caligraphic excellence, and to a few, a person whom they have met and of whom they expect much. I am grateful for the welcome extended to me by the several organisations and individuals whom I have met and hope that I shall be able to work in harmony with them and with all those who have the agricultural interests of the Colony sincerely at heart.

The possibilities and prospects of agriculture in its varied forms in Fiji impress me, and indicate to me the fields of inquiry and extensions as yet barely touched upon. The wonderful results achieved by my predecessor, Dr. Tothill, must for all time be recognised as of immense value to Fiji and the occasion of justifiable pride on his part and on the part of all those associated with him. I have been told that in succeeding Dr. Tothill I have a difficult position to fill, but I am not appalled by the prospect. The necessary concentration of departmental activities upon a menace to the copra industry, the importance of which could not be over-estimated, meant that other agricultural activities had to be placed in a subordinate position, and deferred to a large extent until such time as the major problem had been successfully solved. That time is now with us and those less important matters, now of major import, are before us. It is our duty to face them.

This is not the proper place to define or discuss agricultural policy, but I may perhaps be permitted to sound a note of caution, and to indicate the prime necessity of testing thoroughly under local conditions all matters connected with agricultural development, such as the introduction of new crops, or of new varieties of crops now grown in the Colony; of improved methods of cultural practice; of manurial schemes, and of market prospects, before making recommendations for general adoption. Indiscriminate importation of seeds and plants for trial under any other but expert observation and control is most undesirable and may be dangerous to the welfare of an agricultural community. Many examples illustrative of this truth could be given and those that are with us in Fiji should be more than sufficient. Agricultural development cannot be hurried, nor can it be satisfactorily effected without the sympathy and co-operation of the agricultural community, irrespective of nation or colour. Agriculture is an art and a business and must be so regarded if success is to attend endeavours to improve and develop it. It is a business which cannot satisfactorily progress without

properly directed investigation, and practical assistance by trained scientific observers. This has now been recognised for some time, and the death knell of the old "hit or miss" method has been sounded.

We in Fiji have many lines of agricultural inquiry before us which will receive attention, but early results must not be expected. There exist organisations in many parts of the Empire established to investigate the multifarious aspects of agriculture, and we have the benefit of their trials, errors and successes to assist us in our endeavours. Our success as agriculturalists must, however, mainly depend on our own efforts, actuated and directed by a common bond of sympathy and co-operation, having for its object individual and communal prosperity for these delightful islands in which our sphere of life and work lies.

In conclusion, I would voice what I feel is the general wish for the happiness and success of Dr. Tothill in his new field of activity in Uganda.

STAFF NOTES.

Mr. A. C. Barnes, F.I.C., B.Sc., A.M.I.Ch.E., arrived in the Colony on 9th August, 1929, and assumed duty as Superintendent of Agriculture.

Mr. H. W. Simmonds, F.E.S., sailed by the R.M.M.S. "Aorangi" for Auckland on 5th September *en route* for Trinidad on his mission to introduce colonies of Thrips for the biological control of *Clidemia hirta* (Køester's Curse) in Fiji.

Mr. J. G. C. Campbell, B.Sc., was due to arrive in England on 1st September. He has been appointed as the representative of this Colony to attend the Imperial Mycological Conference to be held in London from 23rd September to 3rd October, 1929.

Mr. W. J. Blackie of New Zealand, has been appointed Government Chemist. He is expected to arrive in Suva shortly.

Captain L. B. Greaves was appointed as an Inspector in connection with the Banana Campaign on 12th August, 1929. He is now at work in the Navua district.

Captain Norman W. Faddy was appointed as an Inspector in connection with the Banana Campaign on 16th September, 1929. He is now at work in the Tailevu district.

CORRESPONDENCE.

It is requested that all correspondence on official matters for the Agricultural Department be addressed to the Superintendent of Agriculture, and not to individual officers personally. This procedure will avoid delay and inconvenience.

NOTE ON DESMODIUM FROM SOLOMON ISLANDS.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

REGARDING the *Desmodium*, introduced from the Solomon Islands by the late Superintendent of Agriculture, Dr. Tothill, this has now been identified for us by Kew and proves to be *Desmodium triflorum* L., and thus proves to be identical with the common species so widely distributed throughout the Group.

LIST OF PLANT NAMES, NAIIVAKASIGA, BUA.
By W. L. PARHAM, Rukuruku Bay, Bua.

Botanical Name.	Customary Name (Wright's list.)	Bua Name.	Remarks.
<i>Parinarium laurinum</i> ..	Makita (Seeman) ..	Makita (tree), Mal (fruit), Mala (foliage).	Mala (foliage), of value for thatch.
<i>Lygodium scandens</i> ..	Wa Kalou (J.H.) ..	Vereverete (i.e., tangle) ..	Medicinal value, also head covering.
<i>Andropogon</i> sp. ..	Co Boi (Seeman) ..	Co bona (wild small type) Yaqu-yaqi (large cultivated) ..	Typical of poor soil. Used as tea. Reputed obnoxious to mosquitoes.
<i>Pleiosmilax nilensis</i> ..	Kadrangi, Wa rusi, Na Kau wa, Sucumaihakaka, Tokakaka.	Tudrumanikaka ..	Medicinal value. Vine of, used for mast rings.
<i>Hoya</i> sp. ..	Wabi (Guffy) ..	Drau bibi ..	Dry rocky hill forest.
<i>Terminalia calappa</i> ..	Tavola (Seeman) ..	Tivi (Tavola vaka-Bau) ..	Local natives maintain these names as correct though aware of Vitilevu usage.
<i>Terminalia littoralis</i> ..	Tivi (Seeman) ..	Tivi ni Yalewa Kaloa ..	Typical of bad edepluc condition; wet cold soil.
<i>Cyperus pennatus</i> ..	Davairaduna (Seeman) ..	Vesivesi ..	Inert silt soils.
<i>Cyperus strigosus</i> (?) ..	.....	Bakovekove ..	Kai Viti come to us often for this for ai lume.
<i>Scleria</i> sp. (?) ..	.....	Batavatava Airumiduna ..	Name is rendering of a trade scent they buy, evidently Eau de Cologne.
<i>Cinnamomum</i> sp. (introduced, cultivated).	Cinnamon ..	Vuniokoloni Koloni ..	Dry medium soil.
<i>Clematis pickeringii</i> ..	.....	Wa mila Wa kaba ..	Imported plants corresponded in having as useless fruit as local ones. Common after fires.
<i>Physalis peruviana</i> ..	Cape Gooseberry (Seeman) ..	Boreboteyadre (name due to children's game).	Foliage used for hair dye. Usable for ink.
<i>Pittosporum richii</i> ..	(Nadiri) Totowiswi (A. Gray), Meade's list.	Totowiwi (tree), Manawi (foliage)	Useless soil.
<i>Lycopodium</i> sp. ..	Lewenimimi (Seeman and Wright)	Sauninini ..	There seems another variety, Vico loa reputed inedible.
<i>Flugellaria indica</i> ..	Turuka (Guffy), Duruka (Seeman)	Vico (also Turuka and Duruka) ..	Poor soil. Medicine.
<i>Erigeron albidum</i> ..	Conipapalagi Wavuwavu (Seeman).	Tubua ..	Cattle fodder.
<i>Ficus bambusaefolia</i> ..	Loseloseniwai (Seeman) ..	Drokanigata (used for tea)	Drought resistant fodder. Medicine.
<i>Sida retusa</i> ..	Qavinilawi W., Cavucidra W. ..	(Qavinilawi) Deni vuaka ..	..

ENTOMOLOGICAL NOTES.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

Volucella obesa.

THIS handsome fly is one of the commonest and most conspicuous insects in Tahiti, Hawaii and the Cooks, but hitherto seems to have been absent from Fiji. On November 8th I took a single specimen in the office, whilst on January 3rd or 4th I observed a second at a lantana flower, also on the Reclamation. There seems little doubt that it is a new introduction and it appears to be establishing itself.

Most of the members of this genus are considered beneficial, acting as scavengers and two have been introduced into Australia to attack prickly pear (which they do subsequent to some previous injury).

The species under review has been intercepted in cucumbers imported into the United States of America but I have no information whether primary or following in some injury or over-ripe condition.—R.A.E., Vol. 10, p. 358).

 WHITE SCOURS AND ALLIED CONDITIONS IN CALVES.

By H. M. STUCHBERY, B.V.Sc., Government Veterinary Officer.

BOWEL disorders which may be classified under the above heading appear to be increasing in Fiji. The outbreaks noticed recently may be classified under two heads—

- (a) those attacking calves from 1-6 days of age;
- (b) those attacking calves of a greater age, generally a fortnight to five weeks old.

The cause of these disorders is attributed to organisms of the Colon Bacillus group, chief among them being the *Bacillus coli* and *Bacillus paracoli*. It would appear from the age at which calves develop the disease that the latter organism is the causal agent of most outbreaks in Fiji.

At the onset of the disease, the affected animals refuse their food and stand in one place with a staring look. They become depressed and may lie down a great deal. Diarrhœa soon commences with greyish white fæces, often foamy and streaked with blood. The odour of this is very foul and penetrating. At first there is much straining, but later the fæces may be passed involuntarily. The body temperature is at first raised 1 to 3 degrees but later returns to normal or even subnormal. Restlessness is often observed. As the disease progresses the animals become very weak, the eyes sink into their sockets and become glazed in appearance. The coat becomes rough and the skin sticky from perspiration, while the anus remains continually open or even prolapsed. Finally the greatly emaciated animals become unconscious and die.

The treatment of this disease lies along two lines, curative and preventative. It cannot be said that curative treatment has, up to the present, been very successful and it is doubtful whether the number of recoveries obtained warrants the extra risk of spreading the disease by these affected animals. With proper isolation, however, this risk should be eliminated.

Curative treatment should be commenced with a purgative, from 1-2 tablespoonsful of Castor oil being especially useful. This should be followed by gruel such as barley water, linseed decoctions, &c. After the adminis-

tration of the castor oil, an intestinal disinfectant should be given daily. Suitable agents are:—Creolin, half teaspoon; Lysol, half teaspoon; or Salicylic Acid, 15 grains. These should be administered with the milk. Enemas of Lysol one per cent. also assist in the disinfection of the bowel tract. Persistent diarrhœa can be checked by the administration of flour gruel, one cupful, sulphate of iron 10 grains. These doses are suitable for calves about one month old, and may be varied according to the age of the animal.

The general comfort of the animal should be attended to. A warm dry place should be provided. Foul discharges should not be allowed to accumulate on the coat. Raw eggs are a great help in preserving the strength of the animal, and black coffee a good stimulant to overcome the general depression which always accompanies this disease.

As the infective agent is contained in the excreta of the animal, the immediate isolation of affected animals is necessary, while all fæces should be destroyed. Calves running in a paddock should be transferred to fresh land, or if they are kept in buildings the latter should be disinfected. A good disinfectant for concrete or other solid floors and walls is one per cent. solution of phenyle. For wooden buildings a lime wash of 1 lb unslaked lime, 1 cup phenyle and 1 gallon of water is suitable. All feeding buckets, &c., should be thoroughly scalded after use.

It is often noticed that calves that have recovered from the disease become unthrifty after weaning. This is due in the majority of cases to infestation by parasites which always attack weakly and debilitated animals more readily than strong ones. For such cases, the following medicines may be used:—

- (1) Turpentine, 1 dessert spoonful; Linseed or Castor Oil, $\frac{1}{2}$ to 1 cup.
- (2) Copper Sulphate, 4–6 oz. of 1 per cent. solution.
- (3) Tartar Emetic, 1 oz; Sulphate of Iron, 1 oz.; $\frac{1}{2}$ teaspoonful of the mixture once a day for one week.

CARBON TETRACHLORIDE IN THE TREATMENT OF WORMS IN A HORSE.

By CHAS. R. TURBET, B.V.Sc., Senior Government Veterinary Officer.

THIS experiment was carried out through the courtesy of Mr. C. Gordon Fenton, of Lami, to whom the mare belonged and to whom I am indebted for keeping the daily observations. It was conducted to test the efficacy of carbon tetrachloride in the removal of worms from horses.

Before treatment, eggs of strongylus worms were very numerous in the fæces of the animal in question. After a few days preparation of bran mash the mare was stabled at mid-day and no food allowed for 22 hours. At 10 o'clock the following morning she was given 40 c.cs. of carbon tetrachloride, 6 oz. Epsom salts and $1\frac{1}{2}$ pints warm water. The bottle was constantly shaken to keep the tetrachloride more or less in suspension. The horse did not object to taking the mixture, but was evidently disgusted with the taste afterwards. She was given light feed about 3 p.m. with water. No motion was observed until about 6 p.m., and as the horse was still stabled, it was evidently the first one since taking the dose. The dung was examined carefully, but nothing found. Another feed was given at 8 p.m. The next morning a fresh motion was found about 7 a.m., and on examination two or three *strongylus armatus* worms were found alive.

Every motion of the horse was observed for four days, and the number of worms passed was at least 500, including *strongylus armatus* and *S. vulgaris*. One motion on the third day was just one mass of worms, probably 80 to 100. No worms were seen on the fifth or succeeding days.

One distinctly noticeable feature was the almost immediate reduction of the abdomen, from being fully blown out or extended, as when late in foal, to less than normal proportions in four days. She looked rather sickly for about ten days and went off her feed, but by the end of two weeks she was on full rations and making splendid improvement in her condition. Her coat became glossy and she moved along with the spring and carriage which denotes good health.

No worm eggs could be found in the fæces after treatment.

Conclusion.—Carbon tetrachloride in a dose of 40 c.c. administered in 6 ounces of magnesium sulphate in $1\frac{1}{2}$ pints of water was effective in removing all the strongylus worms from the alimentary canal of a mare with obvious benefit to the general health of the animal.

THE PRINCIPLES OF BIOLOGICAL CONTROL.

By J. G. MYERS, Sc.D., F.E.S., Imperial Bureau of Entomology.

PROBABLY ninety-nine out of every hundred people, when they think of the contributions of science to human welfare, recall the physical, chemical and mechanical inventions which produced the industrial revolution and are now engaged in the mechanisation of the world, and in the evolution of its new master, the centaur of the new civilisation—that half-man, half-automobile, envisaged by that brilliant recent writer, Woodruff, in *Platos American Republic*. We are not accustomed to think of *biological* inventions; by which we mean, with Haldane, “the establishment of a new relationship between man and other animals or plants, or between different human beings, provided that such relationship is one which comes primarily under the domain of biology, rather than physics, psychology, or ethics.” The application of biology to the solution of human problems has as yet hardly begun. Haldane has shown that the number of great biological inventions can be counted on the fingers of one hand, and most of these were made before the dawn of history.

When mankind was at the hunting stage of culture, living only on animals and perhaps a few plants, secured with the aid of primitive tools, a Malthusian prophet might justly have envisaged, concurrently with improvement in weapons and in hunting technique, a gradual decrease and final extinction of the game, and with it the annihilation of the human race dependent thereon. It is improbable that he would have predicted the innovation—the first great biological invention, namely, the domestication of animals and plants—which was to save the future and ensure the continued evolution of man.

It is interesting to realise that until recent years there had not been, during the whole historic period, any noteworthy addition to the list of man's domestic animals. All had been the servants of man from the dawn of history, they had accompanied him out of the mists of antiquity and had materially assisted his emergence.

The principle of biological control involves a tremendous increase in the numbers of man's animal auxiliaries—it is, in fact, an extension of the first

great biological invention—the domestication of animals. It is true that the animals thus utilised are usually not domestic animals in the strict sense of the term, but there exists every gradation between these and such closely-domesticated organisms as dairy cows. Moreover, in what were in all probability among the first attempts at biological control—the destruction of rats and mice by dogs and cats—animals probably already domesticated were the agents. Ferrets, however, used against rats and rabbits, are very much less domesticated than dogs or cats and form a transition to natural enemies which are utilised without true domestication. It is these latter which are the chief agents in the biological control of insect pests.

The term “biological control” covers at the same time, a multitude of sins and a number of man’s newest and most promising weapons in his struggle with the organic environment. We must carefully examine these, for with the increasing popularity of natural control methods it becomes more and more necessary to define clearly what reputable workers understand by “biological control,” and to distinguish between what should be actually attempted in this sphere, and what must still remain the subject of cautious experimentation. The need is the more urgent from the fact that, as Thompson has recently emphasised, “economic entomology, though it finds in science its principles and its tools, is itself not so much a science as an art, like medicine. As in medicine, the practice of the art is always to some degree in advance of the written recipes and rules, which hardly do more than catalogue what experience has taught. One consequence of this is that while certain general methods gradually develop, there is a considerable period during which they can be learned only from the practitioners of the trade; another is that their general value remains uncertain until their scientific basis is critically examined. Such is at present the situation in regard to the biological control of insect pests”

How then shall we define “biological control”? In a sense any method of combating a pest by means other than direct chemical or physical ones, is biological. The breeding of immune varieties of plants is one such, very promising, means. We would, however, limit the term to the utilisation of one kind of organism for the limitation or destruction of another. The theoretical possibilities of such a method are, of course, extremely numerous but we shall confine the following analysis to those cases in which attempts have been actually made or suggested. Even for these the accompanying table is not complete, but it will serve as a basis for discussion.

I. Control of injurious animals.

A.—By other animals.

1. Control of nematodes by predacious nematodes (Steiner and Heinly, suggestion only, 1922).
2. Control of molluscs by vertebrates (slugs and snails by birds, hedgehogs, &c.).
3. Control of insects and other arthropods by
 - (a) mites.
 - (b) other insects.
 - (c) birds.
 - (d) other vertebrates (e.g., fish and newts against mosquito larvæ, toads against nocturnal insects, bats against mosquitoes).
4. Control of vertebrates by other vertebrates (e.g., fish by fish, snakes and rats by mongoose, rabbits by weasels, mice and rats by birds of prey).

B.—By plants.

1. Control of insects and other arthropods by

- (a) bacterial diseases.
- (b) parasitic fungi.
- (c) algae (*e.g.*, mosquito larvæ by *Chara* spp.).
- (d) phanerogama, *e.g.*, scale-insects on lime trees diminished by allowing Bengal Beans to climb over trees. Montserrat, Ballou). *Melinis* grass against flies and ticks).

2. Control of injurious vertebrates by bacterial diseases, *e.g.*, rabbit in Australia, rats).

II. Control of injurious plants (Weeds) by

- 1. insects (*e.g.*, against prickly pear and *Lantana*).
- 2. mites (*e.g.*, against prickly-pear).
- 3. fungi (*e.g.*, against prickly-pear, blackberry, Californian thistle).
- 4. bacteria (*e.g.*, against prickly-pear).

In addition there are such border-line cases as that of d'Hercelle's bacteriophage; and such indirect control as that of cattle flies by the utilisation of dung beetles, which render the manure unsuitable for their breeding.

Most of these cases represent actual attempts; a few are only suggestions. *As to their relative practicability, it cannot be too strongly emphasised that all are either in the experimental stage or may be dismissed as valueless, save the control of insects and other arthropods by insects.* It is far too frequently forgotten that this and this alone is the only sound general practice in biological control. To this must be credited every one of the sweeping successful applications of the principle. Only when this method has failed after years of trial, should the introduction of natural enemies other than insects (or other arthropods) be contemplated. The introduction and acclimatisation of predacious birds and mammals as a measure against pests (whether insect or vertebrate) has led to such disasters in the past, that it should be universally condemned. I need only mention the introduction of the mongoose into the West Indies, of the stoat and weasel into New Zealand, and of the English sparrow into North American and other parts of the world. So far as insect-eating birds are concerned, we should carefully distinguish, of course between the importation of foreign species and the encouragement of native ones which have been found useful to agriculture. As McAtee (1926) has recently shown, the local birds may be looked upon "as an ever-present force which automatically tends to check outbreaks large or small, among the organisms available to them as food. It is a force which should be kept at maximum efficiency by protective measures and which should be taken into consideration and used whenever possible."

Bird protection then, both passive, by restriction of killing, and active by establishment of sanctuaries and perches, and checking of ground vermin, may be looked upon as a general insurance against insect outbreaks. It can rarely be considered as a measure against individual pests.

Save that in their case, protection is less practicable, the same remarks apply to insectivorous mammals, lizards and amphibians, the two latter being especially important in the tropics.

The control of weeds by means of their insect enemies is still entirely in the experimental stage. The best known attempt—that directed against *Lantana camara* in the Hawaiian Islands, has been successful in that the plant has been largely prevented from seeding by insects introduced from

Mexico. By this means its re-infestation of cleared land and its further spread are greatly checked. The prickly-pear (*Opuntia* spp.) in Australia—the most spectacular weed in the world—is also, according to latest reports, gradually succumbing to the attacks of insects and mites imported, on a very large scale, from America.

Numerous observers, in many parts of the world, have been greatly impressed with the tremendous mortality among certain insect pests, under certain conditions, through the attack of fungous parasites and bacterial diseases. And just as numerous attempts have been made to reproduce these conditions artificially, and to control outbreaks by propagating the disease. In particular instances, sweeping successes have been claimed, notably by Le Moult and by d'Herelle, but later observers have usually failed to obtain similar results. One of the most thorough and careful workers in this field, Paillet (1916) came to the conclusion that “la création d'épidémies artificielles comparables, en intensité et en étendue, aux épidémies naturelles, soit à peu près impossible dans l'état actuel de nos connaissances; trop de ces facteurs interviennent, en effet, dans la propagation de ces épidémies, qui échappent plus ou moins complètement à l'influence de l'homme.” Petch (1921) a mycologist who is perhaps the foremost authority on entomogenous fungi expressed the same conclusion even more strongly when he said:—

“At the present day, after thirty years' trial, there is no instance of the successful control of any insect by means of fungous parasites. If entomogenous fungi already exist in a given area, practically no artificial method of increasing their efficacy is possible. If they are not present, good may result from their introduction if local conditions are favourable to their growth; but, on the other hand, their absence would appear to indicate unfavourable conditions.”

So far as insect pests are concerned—and these are the worst of our troubles, we are thus left with control by means of their insect enemies. But even here, further analysis is necessary before we arrive at what is practicable and promising and what is not. With insectivorous vertebrates we have just seen that importations have usually proved more or less disastrous mistakes while encouragement of local species is recommended as a measure of general insurance. Precisely the opposite has been the case with insect enemies of insects, for here, as noticed above, all the most sweeping successes have been won with introduced parasites, while the attempted encouragement of native ones has usually proved futile. A consideration of these successes, and notably of those achieved in Hawaii, show that the most favourable circumstances may be summed up under four heads:—

- (1) the pests to be controlled are immigrants, accidentally introduced without their natural enemies;
- (2) the indigenous fauna is of a limited and peculiar kind, so that the chances of the immigrants finding new enemies in it are very small;
- (3) the climate is warm and equable, allowing introduced parasites to multiply without seasonal checks;
- (4) there are only a few main crops, so that high organisation and centralisation are possible, and a small improvement is rendered important by the large scale of operations.

Probably no other part of the world is quite so favourably situated as Hawaii in reference to all four of these conditions. But it is safe to say that any country possessing these four qualities in some degree, is favourably situated for biological control. One would expect that once suitable natural

enemies were discovered, imported and established, the task would in most such cases be accomplished. Probably the most unfavourable regions in which to attempt control of this nature lie in continental areas, with a rich and varied fauna, and a "temperate" climate, with a cold winter. In such areas it might be necessary to breed the parasites continuously in the laboratory and distribute them periodically, so as to force them into a condition of permanent dominance, to use the term of H. S. Smith. Such is the method used with the Australian ladybird, *Cryptolaemus montrouzieri*, in California, against the citrus mealy-bug. It is, of course, considerably more expensive than mere introduction and establishment accomplished once and for all, but at least in the citrus industry, it remains less costly than chemical measures of control.

This principle of assisting, as it were, the work of parasites already established, may theoretically be extended to indigenous natural enemies of pests either native or imported. In fact, the large scale utilisation of parasites already present, notably those of the codlin moth in California and of the sugar-cane borer (*Diatraea*) in Louisiana, is one of the latest developments of applied entomology. But such extension, whether on a large or on a small scale, has nowhere yet met with any striking success, and biological control as a whole should not be judged by the trial of it alone. The corollary is that the best results in biological control are to be expected in the future, as they have been obtained in the past, from the introduction and establishment of parasites from other regions.

When we come to the tropics it is often a matter of the greatest difficulty to decide whether a given pest is an introduced or an indigenous insect, and provided the entomologist ascertains exactly what parasites are attacking it in the various regions of its range, this becomes largely an academic question. The sugar-cane frog hopper in Trinidad, evidently an indigenous insect, has very thoroughly adapted itself to cane-field, *i.e.*, essentially exotic conditions, while its local enemies have very largely failed to do so. The position thus simulates that of an insect introduced into a new country, without its natural enemies, and the way is open for the importation and establishment of foreign parasites which are as well adapted to cane-field conditions as the frog hopper itself. The same principle applies to a number of other tropical pests.

A most essential part of the work consists in freeing the imported parasite from its own natural enemies (hyperparasites) before it is liberated. Mistakes of this kind are usually irrevocable.

The controversy as to the necessity for a sequence of parasites to attack various stages of the pest insect, with the dangerous tendency to the opposite extreme of super and co-parasitism, or the injurious competition of several parasites for the same individual hosts, seems now to have been resolved in the policy of sending one or two judiciously selected species at the beginning and observing their effect, before introducing others. The choice of species to introduce must, in the present state of our knowledge, be left in each case to the judgment of the specialised investigator who can study the pest and its enemies in the different parts of its range.

The emphasis on foreign parasites implies, of course that the task is not one for the local entomologist to perform single-handed. Biological control offers an extremely promising field for co-operative research, and with the foundation by the Empire Marketing Board of a special laboratory for this work under the Imperial Bureau of Entomology, its rapid further develop-

ment along these lines, throughout the Empire, seems assured. The mission of the present writer to the extremely promising field of the West Indies is the latest extension of the same organisation.

NOTES BY H. W. SIMMONDS, F.E.S., GOVERNMENT ENTOMOLOGIST.

The biological control of pests and weeds is of particular importance to Fiji, with its limited population, abundant rainfall and fertile lands, so that the article by Dr. Myers dealing with the scope and limitations of this subject should prove of special interest.

Dr. Myers strongly condemns the introduction of birds into a new country and quotes certain disastrous experiments in support. It should, however, be pointed out that the English sparrow and most of the introductions into New Zealand were omnivorous birds, which in their new home would naturally first select that which they preferred to eat and later, as that became scarce, turn to other foods.

The acclimatisation of purely insectivorous birds has seldom been attempted and there should be no more risk with these than with a specialised insect. If a bird can be transported for weeks across the ocean without the attention of a highly skilled ornithologist it must be too adaptable and generalised in its feeding requirements to be safe to transport to a new country.

In New Zealand and many other countries formerly covered with forest with a highly specialised avifauna the clearing of the land for cultivation led to the retreat of the native birds with the receding forests. Their replacement is a matter of great difficulty, as most birds of the open are general feeders and no attempt seems to have been made to make use of those which are purely insectivorous, such as nightjars, swallows, podargus and others whose transport presents great difficulties, but whose introduction would have avoided the disasters attendant upon the ill-advised use of sparrows, blackbirds, &c. It does not appear that the introduction of the birds is responsible so much as the absence of careful prior investigation, and it is only by the most detailed investigation that similar disasters with insects have been avoided.

COCONUTS, PINEAPPLES AND BANANAS IN MALAYA.

THE following abstracts from the Annual Report on the Department of Agriculture, Straits Settlements and Federated Malay States, for 1928 are of interest to agriculturists in Fiji, dealing as they do with these important crops:—

COCONUTS.

Area.—It is estimated that the total area now planted with coconuts in Malaya is approximately 520,000 acres, representing an increase of about 3 per cent. since the year 1924. About three-quarters of the planted area is believed to be made up of small holdings.

Markets.—The Singapore market price for copra, which at the end of 1927 was \$11.50 per picul (133½ lb), opened in January, 1928, at \$11.90, around which price it stood until the end of the month. Thereafter the price was maintained between \$11.50 and \$11.35 until the end of May. It subsequently declined to \$10.10 at the end of August and then varied between this figure and \$10.60 closing at the end of the year at \$10. The average price for the year was \$10.90 as compared with \$11.17, \$11.80 and \$11.95 in 1927, 1926 and 1925 respectively.

Exports.—The exports of copra from the Federated Malay States for the years 1925 to 1928 are shown in the following table:—

State.	Quantity in tons.				Value in dollars.			
	1925.	1926.	1927.	1928.	1925.	1926.	1927.	1928.
Perak ..	40,007	44,542	39,499	45,451	7,830,274	8,905,033	6,862,402	7,535,319
Selangor ..	15,426	16,963	14,120	20,148	2,909,119	3,212,553	2,615,641	3,435,968
Negeri Sembilan ..	2,236	3,417	3,302	2,251	463,494	575,451	562,528	381,675
Pahang ..	315	907	615	654	57,412	158,733	102,255	106,746
Total F.M.S.	57,984	65,829	57,536	68,504	11,260,299	12,851,770	10,142,826	11,459,708

Of the total for 1928, 20,486 tons were exported direct to foreign countries and 48,018 tons to the Straits Settlements.

The net exports of copra and coconut oil from Malaya during the last three years were:—

Year.	Copra.		Oil.		
	Quantity. Tons.	Value. Dollars.	Quantity. Tons.	Approx. copra equivalent.	Value. Dollars.
1926	104,653	21,852,330	8,458	14,000	3,090,953
1927	86,649	16,562,493	10,242	17,000	3,448,057
1928	95,091	18,747,129	9,828	16,400	3,168,881

General.—Whereas the crops for 1927 were below average, those for 1928 were satisfactory in most districts. The improvement in crop is partly responsible for the increase in exports, although an increase in the producing area is also a contributing factor, more especially in Perak, Selangor and Johore.

Data have been compiled from 30 representative estates in Malaya, which show that the average production of copra per acre from estates under European management is 8.73 piculs (1,162 lb) and that 251 nuts are required to produce 1 pikul (133½ lb) of copra (4,217 nuts per ton of copra).

Statistics have also been collected with reference to dwarf coconuts. These show that under fair average condition and with good management eight-year-old dwarf palms have given an average production of 11.68 piculs (1,557 lb) of copra per acre. One estate has produced 19.29 piculs (2,572 lb) per acre over an area of 100 acres, but this is exceptional. Under favourable conditions dwarf coconuts, especially the yellow variety, have not proved as robust as tall palms, but where conditions are good the green dwarf is a sound proposition.

The data collected also show that there is a seasonal variation in output of copra per acre amounting to about 15 per cent. of the average crop.

Experimental Investigations.—The information obtained from the records of individual yields from 471 trees, growing under average estate conditions, during a period of eight years, may be summarised as follows:—

- (1) the co-efficient of variability of an average population is as much as 34 per cent. of the mean production per palm;
- (2) variability in cropping per palm per annum ranged from 5 to 115 nuts;
- (3) of an average population, 19 per cent. of the palms are not profitable in that they yield under normal treatment less than 40 nuts a year;
- (4) fifteen per cent. of the palms produce 24 per cent. of the total crop;
- (5) poor yielders remained poor yielders, while good yielders were constant to that character.

Data have also been compiled which show that the copra content of nuts from different palms of the same variety varies from 79 to 131 per cent. of the mean copra production per nut. Further data regarding variation in the oil content of copra from different palms and seasonal variation in oil content of copra from the same palms, are in process of compilation.

The Coconut Experimental Station at Klang has been maintained in good condition and the general growth of the palms is satisfactory. The manurial, cultivation and catch crop experiments are also being maintained on this area.

Manurial experiments on mature coconuts have been commenced on an estate block of 18-year old palms of which the individual yields are known for the last eight years.

The flowering and fruiting characters of three races of dwarf palms were recorded for the fourth year in succession and will be published in the near future.

A scheme for instituting research work on the preparation of copra has been approved and the Empire Marketing Board has undertaken to contribute a half share of the provision made for this work. In the meantime preliminary chemical investigations connected with this scheme have been commenced. Several analyses of copra from different estates have been carried out, as a result of which it appears that the oil content of estate copra, calculated on a moisture free basis, varies from 64 to 67 per cent.

Diseases and Pests.—The situation with regard to the complicated problem of palm diseases in Malaya has been considerably clarified. A general account of the whole of the palm disease investigations was published in the *Malayan Agricultural Journal* Nos. 9 and 10 of Vol. XVI.

Effects of Lightning.—Supporting evidence has recently been obtained which clears up the position with regard to bud-rot due to lightning, and shows that lightning is a factor of importance in the causation of palm diseases, more especially on estates of tall coconuts. Small clumps are often struck with the result that two or three palms in the centre are killed and exhibit symptoms resembling those of bud-rot, while from 6 to 12 of the surrounding palms are slightly damaged, having their leaves broken or discoloured at the tips. These findings are of importance since, when considered in conjunction with other evidence, they strengthen the probability that no definite form of epidemic bud-rot exists in Malaya. They also help to simplify the general problem of palm diseases by removing from the field of investigation certain phenomena which tended to complicate it.

The Greater Coconut Spike Moth (Tirathaba rufivena).—Work on this pest has been continued and it has now been confirmed that the removal of the sheath just before it opens results in an increase in the percentage of nuts remaining on the spike. The value of this method of treatment depends on economic considerations, but, since only 30 per cent. of the original female flowers reach maturity, it is probable that even a small increase in this percentage would render such treatment profitable.

Records made in the course of this investigation show that the fall of immature nuts reaches its maximum in the fifth or sixth week after the sheath has burst and that there is a slight secondary nut-fall in the eleventh to fourteenth weeks. All the factors influencing nut-fall have not yet been determined.

Setora nitens.—An outbreak of this Limacodid was reported on an estate on the Bernam River and later in the year on several estates in Lower Perak district. At first only the leaves of young palms were attacked, but later older palms in bearing became infested. Control measures recommended were hand-picking caterpillars and pupæ, spraying young palms with lead arsenate solution, and encouraging the spread of a Tachinid parasite. This last measure is achieved by the use of special cages containing a number of pupæ of *Setora* and so constructed as to allow the adult flies emerging from parasitised pupæ to escape, while the moths emerging from healthy pupæ are retained for destruction.

Artona catoxantha.—An outbreak of this moth in Singapore Island was reported in October, but it disappeared again during wet weather in November. Two other outbreaks on the South Coast of Johore were controlled by the parasites of the pest.

FRUIT.

Pineapples.—The area under this crop and the export of canned pineapples have been well maintained during the year. In Johore, where most of the fruit is now grown, three new factories were in course of erection. These will bring the total in Johore up to nine factories, while there are five others operating in Singapore and one in Selangor.

The following have been the exports of canned pineapples from Malaya during the last three years:—

	1926.	1927.	1928.
Weight in tons ..	40 634	40,134	46,400
Value in dollars ..	7,669,784	8,296,656	8,421,230

The United Kingdom is the principal consumer of Malayan canned pineapples, taking about 80 per cent. of the exports and offering a good market for fruit of reasonable quality at a moderate price.

With the help of the Empire Marketing Board and the Malay States Information Agency, exhibits of Malayan (Singapore) canned pineapples were staged at the British Industries Fair in London, the Canadian National Exhibition in Toronto, and the Imperial Fruit Show in Manchester.

These exhibits attracted considerable attention. Recent communications have, however, emphasised that, if Malaya is to obtain the full benefit of the excellent facilities thus afforded for bringing this commodity to the notice of the consumer and to be enabled successfully to face competition on the British market, the different grades of the product must be carefully standardised.

This important aspect of the industry was discussed at an informal meeting of packers and exporters with Mr. E. M. H. Lloyd of the Empire Marketing Board held in Singapore on the 2nd May, 1928. At this meeting both sections of the industry were able to exchange views and to learn from Mr. Lloyd the methods successfully employed in other countries for standardising similar agricultural produce.

Further investigations are being undertaken by this department with a view to consolidating the position, which the Malayan product holds on the United Kingdom market and to extending the demand to other parts of the Empire.

Bananas.—Considerable areas of this crop are established in Negri Sembilan as a sole crop, and in Selangor, Perak, the Settlement of Penang and Kedah as a catch crop usually with young rubber. All the produce is sold inside Malaya.

The study of banana diseases and of the relative immunity to these of the numerous local varieties of banana has been continued in an endeavour to obtain varieties immune to Panama disease. As mentioned in previous reports this study is of considerable importance from an Imperial point of view and is being undertaken in co-operation with the Royal Botanic Gardens, Kew, and the Imperial College of Tropical Agriculture, Trinidad.

A full review of the year's work is contained in the annual report of the Mycologist. It will suffice to state here that the two local varieties, which give good promise of conforming to the requirements of the European market namely, *Pisang embun* and *Pisang restali*, have been proved to be susceptible to Panama disease; and that this disease has been found in three small areas of land in different parts of the Peninsula.

A local bacterial wilt disease of bananas, similar to that occurring in Trinidad, is also being fully investigated.

A USEFUL FORMULA.

(From *Market Gardening in Queensland*, 1920.)

LIKE the lime-sulphur wash, this material has valuable insecticidal and fungicidal properties, and is especially valuable for treating all kinds of mites and red spiders, as well as the various mildews attacking roses, melons, cucumbers and many cultivated flowering plants. It is a very valuable spraying material, and one that should be much more used than it is, and I therefore give its method of preparation, which is as follows:—

Boil 3 lb of 98 per cent. caustic soda and 6 lb of sulphur in two gallons of water till dissolved; the result is a strong solution of sulphide of soda which can be used either diluted with plain water or with soap and water— $\frac{1}{4}$ to $\frac{1}{2}$ lb of soap to the gallon of water.

The concentrated solution should be reduced to one-sixtieth with water or soap and water, the two gallons thus producing 120 gallons of spraying material. Used at this strength it is very effective on all red spiders, mites and also young scales when newly hatched, and can also be applied to ripening fruits to prevent rot caused by fungus growths or to prevent mildew on roses, pumpkins, marrows, cucumbers, &c. (1 oz. soda, 2 oz. sulphur to 1 pint of water, prepared as above. Dilute to $7\frac{1}{2}$ gallons for use).

If desired caustic potash can be used in the place of caustic soda, the result being the production of sulphide of potash or, as it is commonly called, liver of sulphur.

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 2.]

FOURTH QUARTER, 1929.

[No. 4.

EDITORIAL.

It is unfortunate that a higher proportion of original articles cannot be obtained for inclusion in issues of the Journal at present, owing to the fact that the effective scientific staff of the Department is depleted. The Government Entomologist is in Trinidad on a special mission; the Government Mycologist is on leave; the new Government Chemist has only just assumed duty and but one Veterinary Officer is in the Colony.

In recent issues of contemporary Journals a number of valuable articles, having a direct bearing on Fijian agricultural conditions, have appeared and these have been freely drawn upon for our Journal. It is hoped that next year arrangements can be made for the inclusion of a greater number of original articles by members of the staff.

Fiji Agricultural Show.—The Annual Show held by the Fiji Show Association took place in Suva on October 14th and 15th. On the whole it was a very creditable exhibition, but suffered from poor display in the agricultural sections, and insufficient lighting throughout both the Customs sheds in which the Show was held. The Colony depends entirely upon agriculture for its prosperity and an Annual Show provides an excellent means of fostering the interests of all classes, whether directly concerned in agriculture or not. The Fiji Show Association is to be complimented on the work that it has done in this direction, but it seems that the time is with us when its functions should be extended so that it may become the parent Agricultural Association of the Colony, with which is affiliated such other organisations as the Fiji Planters' Association, the Stock Record Association and any other subsidiary bodies whose interests are concerned with branches of Agricultural effort. The need of a more satisfactory place in which to hold the Annual Show has been felt for some considerable time and progress in the desired direction appears still to be hampered by financial considerations. It is to be hoped that these difficulties will be surmounted in the near future and the Agricultural Organisations of the Colony placed upon a sounder basis.

Fruit Production.—The banana industry suffered a severe setback by the serious extension of ravages due to the root borer *Cosmopolites sordidus*, and this has been reflected for a considerable period by the reduction in exports of fruit to New Zealand. It is interesting to be able to record that a method for destroying the pest and its eggs in suckers to be used for planting has been devised by Mr. H. W. Simmonds, Government Entomologist, and so far as can be judged from the results of earlier experiments, gives promise of success when applied on an extended scale. The method briefly is to immerse the suckers to about four inches above the corm in water for a period of 21 days. To test this method in the field, arrange-

ments have been made for the acquirement of demonstration plots in the principal banana producing areas and these will shortly be planted out with suckers treated in the manner prescribed.

Complaints have been received from merchants in New Zealand in regard to the quality of the bananas supplied from Fiji and it appears that some exporters have not taken sufficient care to see that their fruit was carefully selected and properly packed. Complaints regarding small, inferior, and ripe fruit in the middle of cases of apparently satisfactory fruit reflects very badly upon the banana exporters of Fiji. To maintain and develop our position in the New Zealand fruit market demands the careful attention of everybody connected with the fruit industry. It is essential to maintain a standard—as high a standard as possible certainly—but nevertheless there must be a standard. Shady practices of the nature mentioned discredit not only the exporters immediately responsible but those who endeavour conscientiously to maintain a uniform and satisfactory standard of quality. Instructions have now been issued that the Fruit Export regulations are to be strictly enforced and if exporters suffer thereby it can only be attributed to their own fault.

Fiji Live Stock Record Association.—At a meeting of representative stock owners held in the office of the Department of Agriculture during October, it was agreed that the Fiji Live Stock Record Association had never functioned properly and that it should be re-formed. A new Board of Directors was appointed and a number of alterations to existing regulations suggested. A few days later, the Board of Directors met and agreed upon certain amendments to the regulations which were submitted for approval by His Excellency the Acting Governor in Council. The amended Regulations have now been sanctioned and are published for general information in this issue of the Journal. Sanction has been given for the use of the Journal as the official organ of the Association. In it will be published records of meetings, a list of members, and the names of owners of animals registered in the Herd Book of the Association. It is to be hoped that the re-formed Association will attract members from the agricultural community directly interested in stock, and that it will prove to be an active and effective body. The Department of Agriculture will give every possible assistance in the conduct of the affairs of the Association and adequate publicity through the medium of this Journal is assured. It remains for stock owners to signify their approval to the objects for which this Association has been formed and enroll themselves as members. The small subscription and fees for registration are such as to impose no hardship upon any stock owner who wishes to join. Forms of application for membership can be obtained from the Secretary, Fiji Live Stock Record Association, Department of Agriculture, Suva.

Agricultural Legislation.—During the recent session of Legislative Council a new Ordinance entitled the Noxious Weeds and Diseases of Plants Ordinance passed all its stages. The object of this is to replace three older Ordinances, the Diseases of Plants Ordinance 1913, the Noogoora Burr Ordinance 1919, and the Diseases of Plants Amendment Ordinance 1926. As stated in the explanation of the draft Bill the principal reasons for the introduction of the new measure are to prohibit the importation of plants which may be injurious and to prohibit the planting of land declared to be infected with plant diseases. The measure is intended to be an additional means of protecting agricultural interests in the Colony against the spread of disease and the danger attendant upon uncontrolled growth of

noxious weeds. For the time being existing Regulations, in so far as they apply, will remain in force, but it is hoped that new Regulations will be promulgated at an early date.

At the same session of Legislative Council it was agreed that Government should continue the present control of the Tailevu Dairy Factory until the end of 1930. Under the system of management introduced in 1928 the factory has proved to be a sound commercial undertaking. It has accumulated quite substantial profits which are held on account of the suppliers of butter fat and which form the nucleus of a fund to provide capital for the formation of a Co-operative Company by the Tailevu settlers at a later date. The view was expressed in Council that it would be better if Government undertook to continue the management of the factory for a greater period than one year, but His Excellency the Acting Governor intimated that he was not prepared to commit the new Governor to a greater extent than appeared to him to be necessary and the adoption of the motion to continue control for a year would not preclude the possibility of control for a further period after 1930. The dairy settlement at Tailevu is assured of Government's sympathetic control for at least another year and an undertaking has been given that nothing will be done to prejudice the interests of the settlers in that area.

Imperial Agricultural Bureaux.—At the Imperial Agricultural Research Conference held in London in 1928 it was recommended that further Agricultural Bureaux be established to act as "effective clearing houses for the interchange of information of value to the Research Officers in agricultural science throughout the various parts of the Empire." Two such Bureaux—the Imperial Bureau of Entomology and the Imperial Bureau of Mycology—have been established for some years and have proved of immense value to Colonial Governments and to the Specialist Officers who have been able to apply to them for advice and information. The new Bureaux comprise the following:—

- (1) Soil Science.
- (2) Animal Nutrition.
- (3) Animal Health.
- (4) Animal Genetics.
- (5) Agricultural Parasitology.
- (6) Plant Genetics for crops other than herbage plants.
- (7) Plant Genetics for herbage plants.
- (8) Fruit Production.

These will be centered upon established research stations in Great Britain and Officers and Agricultural Departments in the Colonies will now be able readily to obtain information regarding the general progress of scientific research in the subjects in which they are interested. The main functions of each Bureau will be the collection and distribution of information on the particular subject or subjects with which it is concerned.

Official correspondents of the different Bureaux will be appointed from the staffs of Agricultural and other scientific departments throughout the Empire. The duty of such correspondents will be to keep the various Bureaux informed of the progress of research work in the particular subjects in the Colony in which the correspondent is working and make suggestions regarding the work and activity of the Bureau. Quoting from a memorandum on the subject: "It is expected that these correspondents will make it their duty to take a lively interest in the function and work of the Bureau and facilitate its activities in the interests of research workers in the Empire as a whole."

Four, and possibly five of the new Bureaux should prove of considerable value to the Colony of Fiji. These are:—Animal Nutrition, Animal Health, Agricultural Parasitology, Fruit Production, and Soil Science.

Quoting from *Tropical Agriculture*:—"It will be realised no doubt that Bureaux have been primarily designed to supply information to research workers and that the responsibility, therefore, of spreading new information will essentially remain in the hands of the latter. In other words, the Bureaux as a central organisation will act as an Intelligence Service which will supply its information to the research officials of the local teaching Institutions or Agricultural Departments. This information will then be passed on to the local research investigator who will in turn disseminate it amongst the planting community. In the event of information being required the process will merely be reversed. The new Bureaux will naturally have to organise their work on their own lines as the problems to be confronted will vary according to the subjects dealt with. The primary needs, however, of a research officer, will have to be kept well in mind. The existence of the new Bureaux will be amply justified if they can keep him up to date with, preferably, as much original literature as possible on the subject studied, together with translations of the more important works, the crying need at present of numerous investigators; if they can help him to identify and, if necessary, to collect specimens from all parts of the world, and, in short, if they can keep him in touch with the whole realm of his pursuits. The research worker could help, in turn, by supplying the Bureau with a concise account of his own activities, and of any new observations he may have been making. The result of such co-operation has, in the past, been invaluable, and it can only be hoped that such co-operation will continue to exist with the formation of our eight new Imperial Agricultural Bureaux, whose future development will be watched with great interest."

SOME ASPECTS OF RICE CULTURE IN FIJI.

BY J. P. TARBY.

A PAMPHLET received from the Department of Agriculture, United Provinces, India, recommends the drainage of rice fields that are to be puddled and submerged, to promote aeration. Rice has been grown in this Colony for many years and the yield of the crop has appreciably decreased. With a view to improving the present yield, a study of the recommendation as affecting our rice fields is called for and a survey of certain other conditions in local rice culture, would seem opportune.

2. *Drainage of rice fields to promote aeration.*—While the promotion of aeration by drainage is well known and its adoption in submerged rice fields in the United Provinces, India, may be advisable, the necessity for its application to the rice fields in this Colony does not, in my opinion, arise, as, except in few instances, rice is grown in more or less saturated rather than submerged soils. This is due to the fact that irrigation being nowhere practiced, and the rainfall being intermittent and comparatively light, submergence is only occasional and of short duration. Even after heavy or prolonged rains, few fields remain submerged for more than a few days. On the contrary, it is not uncommon during a normal season for the soil to become dry. It may be said therefore that the majority of our crops are grown under conditions alternating between wet and dry.

3. Further, as only one crop is grown yearly, the rice lands are fallowed for several months during which very little rain falls and the soil cracks and dries up to a depth of two or more feet. And again, before being planted, all rice areas are twice ploughed and harrowed, never puddled, except occasional small plots, and the crops during the early stage of their growth are hoe-weeded once or twice.

4. Under such conditions, so favourable to aeration by natural and cultural processes, and in the absence of the very conditions—puddled soils and prolonged submergence—for which drainage is recommended, the necessity for draining our rice fields to promote aeration does not seem to arise. Moreover, the bulk of the present rice fields are so small and widely separated that any scheme for their drainage would involve an expenditure much in excess of any good (problematical) that might result from it.

5. *Aeration of rice fields condemned.*—It is interesting to note, however, that while the recommendations of the Department of Agriculture, United Provinces, favour the aeration of rice fields that are to be submerged, W. P. Kelley in *Fertilisation and Management of Rice Soils*, Hawaii Agricultural Experimental Station, condemns the practice on the grounds that:—

(a) Nitrates which are formed in the soil following aeration are broken down (denitrified) under submergence, into largely, nitrites which are toxic to rice, and that;

(b) nitrate as a form of combined nitrogen is ill-suited to assimilation by rice, in fact it is unsuited to its nutrition.

6. Kelley contends that the one condition that is most obviously different in rice (wet) soils and dry lands is that of aeration. The fact, he says, that aeration is essential to the successful growth of most crops, and the belief that fertility is in some way dependent upon its maintenance, has caused agriculturists to recommend for rice soils practices designed to secure aeration in the belief that this is as essential for rice culture as for culture of other crops. Experiments, he declares, are not wanting, however, which show this to be untrue. In fact, Kelley's experiments indicate quite conclusively that for the most successful production of rice all conditions which tend toward aeration should be avoided.

7. *Nitrate unsuitable to rice.*—Regarding the denitrification of nitrates under submergence into nitrites which are poisonous to rice, and the practical non-availability of nitrogen in the combined form of nitrate to rice, Kelley is just as emphatic as he is on the question of aeration. He is supported in the former by Nagaoka, Japan, while other experimenters are in agreement with him on the latter. In a series of pot experiments both Kelley, Hawaii, and Colman and Ramchandra Rao, India, found that where nitrate was the only form of combined nitrogen present rice made very poor growth. The net result of all these, and a number of other experiments, to quote Kelley, forces the conclusion that nitrate is not a suitable form of nitrogen for rice. He is not, however, without opponents on this question.

8. The latest experiments on the *Availability of Nitrogenous Fertilizers to Rice* by R. P. Bartholomew, Assistant Agronomist, University of Arkansas, have just been published in *Soil Science*, Vol. XXVIII, No. 2. Like other investigators whose experiments are contrary to Kelley and his supporters' findings on the low nutritive value of nitrate to rice, Bartholomew concludes that it is safer owing to the uncertain behaviour of nitrates under anaerobic conditions, to recommend highly the use of organic forms of nitrogen, or the use of ammonium compounds, such as ammonium sulphate or ammonium phosphate.

9. Such evidence, the result of extensive and careful experiments, is not only opposed to the principle underlying the recommendations made by the Department of Agriculture, United Provinces, but has a direct bearing on rice culture in this Colony, for even if denitrification of nitrates into nitrites does not take place to an undesirable (toxic) extent, the considerable amount of nitrates which must result from the natural and cultural conditions facilitating aeration in our rice fields would appear to be, at the best, of little manurial value to our crops. This point I wish to strongly emphasise, as my experience in rice culture is that crops and yields depend almost directly on the percentage of organic matter in the soil. To this fact, in my opinion, is due the marked decrease in yields of our rice crops.

10. *Lack of organic matter in Fiji rice fields.*—As long as our rice lands were new and rich in organic matter, ammonification took place and the rice plant was provided with nitrogen in the form most suited to its nutrition—ammonia. Now, however, that those lands have been cropped for many years, without either the application of ammonical manures or the ploughing in of organic matter, this source of nutrition has been greatly reduced and the yields of the crops are 20 per cent to 30 per cent less than when these lands were new, or comparatively so. There are still a few small good yielding areas but even on these the yield has declined.

11. *Serious defects in local rice culture.*—Throughout the Colony the custom when reaping rice crops is with very few exceptions, to cut the plants 4 to 6 inches above the ground and to carry away the straws with the heads attached, to a convenient place where they are heaped for hand threshing sooner or later, according to weather conditions. To an acre of ground, one or two of such heaps are formed, usually on the same sites each year, and after threshing the straws are either left to rot or are burnt in the heaps, or as is more often the case, are partly or wholly removed for house-thatching or for use in other ways, in which case they are never returned to any part of the land. Excepting near to a grower's home, where the land is higher and the soil more friable, no nitrogenous crops are grown for the improvement of the soil. Even when grown in small plots near to a house, the crops of beans are for commercial purposes or home consumption; so that except for the short rice stubbles and a crop of weeds, which are ploughed into the land when preparing for the next crop several months after the rice has been cut, nine tenths of the land, or the whole of it if the straws are removed or burnt in heaps, receives no organic matter to keep up or increase the supply of it in the soil for its mechanical improvement or for the provision of the rice plant's most nutritious food—ammonia.

12. This lamentable state of affairs does not obtain in rice culture only but it is very general, though to a lesser extent, in other agricultural industries in the Colony, except cane growing by the Colonial Sugar Refining Company Limited who pay particular attention to the improvement of the soil, both by mechanical and manurial means. Lands producing commercial crops such as coconuts, rubber, cotton, bananas, maize, &c., are generally never helped with leguminous fertilizers either ploughed into the soil or as cover crops. The cultural practices of the majority of the planting community other than Indians, leave much to be desired and those of the Indian settlers outside the cane areas are of a slipshod style and a "trust in God" for results. To return to rice, this practice has been going on for years and will continue to do so unless steps are taken to teach the Indian rice growers the value and use of organic matter in the soil. Any precipitate or direct attempt, however, to attain this desideratum will meet with resentment rather than response, for the reason that the

use of rice straws for house thatching and other purposes is as essential to the rice grower as cane leaves are to the cane grower and swamp grass is to the native, for like purposes. The case, however, can be met satisfactorily, but not without much endurance and teaching.

13. *Nitrogenous Manures*.—Authorities on rice culture throughout the world, as a result of many experiments, are in accord on the matter of ammonia, as sulphate of ammonia or in nitrogen form in legumes, being the most nutritive food for rice. While sulphate of ammonia yields the best results, it is costly and I fear beyond the means and reach of the Indian rice growers. Legumes, on the contrary, though perhaps less effective, are well within the means of the Indians and forming a part of their diet, their cultivation is understood by them. The legumes grown for manurial purposes, principally by the Sugar Company, are Mauritius bean (*Stizolobium aterrimum*) rice bean (*Phaseolus calcaratus*) and cowpea (*Vigna catjang*), while those grown by Indians for food purpose are pigeon pea (*Cajanus indicus*) urd (*Phaseolus mungo*) mung (*Phaseolus radiatus*), &c., &c. There are also several varieties growing wild, among which is the rattlepod (*Crotalaria saltiana*?) which should possess a high content of nitrogen and grows on every kind of soil. Clovers have been tried on many occasions without success. Other legumes have lately been introduced but are not yet established. Further varieties should be imported, more particularly quick growing ones to cover the ground before weeds have time to spring up. The Sugar Companies would welcome any variety that would answer this purpose. The soy bean (*Glycine hispida*) varieties, especially, should be tried because of the great demand for these beans in the world's markets. From such a stock to pick from, one or more varieties can be selected for growing as nitrogenous fertilizers to the rice fields but especial attention should be paid to the *Crotalaria* owing to its high nitrogen content, the ease with which it grows on all kinds of soil and the fact that it is unpalatable to cattle, who do such damage among other legumes.

14. (i) Seed selection, (ii) treatment of paddy between cutting and threshing operations, and (iii) propagation of approved varieties call for special attention. The first is hardly ever practiced and accounts in some measure for the decrease in yield; the second is responsible for the cracking and yellowing of the grain, while the third, due to the Indian's conservatism and his preference for certain varieties for home consumption, is not making sufficient headway in spite of the higher prices offered for the better varieties for commercial purpose.

SOME FEEDING EXPERIMENTS UNDERTAKEN IN TRINIDAD WITH LIOTHRIPS URICHI (KARNY).

By W. Cook, B.A., (Cantab.)

INTRODUCTION.

Clidemia hirta, D. Don, belongs to the order Melastomaceæ, and occurs in Fiji (having been introduced) as a serious agricultural pest.

It occurs in Trinidad, generally distributed over the island, and is of no importance agriculturally, as it is always found with definite plant associations, and is generally attacked by *Liothrips urichi*.

As the Fiji Government have a proposal under consideration to introduce this thrips into Fiji for the control of *Clidemia hirta*, some indication of its feeding adaptabilities was thought necessary. The Fiji Government

applied to the Imperial College of Tropical Agriculture Trinidad for some feeding experiments to be carried out, and the writer received this problem from the Principal as part of his work during the academic year 1928-1929.

METHODS AND OBSERVATIONS.

Each intended host plant was tried four times; twice with thrips in their first and second larval stages, and twice with an equal proportion of male and female adults. Controls were effected by placing thrips, in the stages corresponding to those placed on the crop plant, on small plants of *Clidemia hirta* in pots, and keeping them under exactly the same conditions as those on the crop plant.

Two controls were used for each different crop plant, one for the adults and one for the larvæ.

Various methods were tried for introducing the thrips on to the leaves of the plant. The method that gave the most satisfaction was by means of a blunt bent "seeker" for the adults, while for the smaller larvæ a thin two inch black entomological pin was employed. The pin or "seeker" was gently placed underneath the thrips as it was stationery, feeding on the leaf. It was then transferred to the leaves of the crop plant by gently brushing the end together with the adhering thrips on the surface of the leaf until the thrips became detached from the instrument and adhered to the plant. After some practice the thrips were transferred in this manner without any damage to them.

A camel's hair brush did not raise the thrips effectively from the *Clidemia*, as the hairs were pushed aside by those on the leaves of the plant.

As in the case of the controls the crop plants were grown in, or transferred to, pots and were infected while still young.

Coconut, cocoa, and hevea seedlings were used, while the breadnut, the seeded variety of the breadfruit, was used instead of the latter. Sugar cane, sweet potatoes and cassava were propagated from cuttings, while the bananas were taken from the sword suckers of the varieties concerned. Taros and yams were grown from rhizomes.

There is no bean grown in Trinidad known as the Rice bean, so the Soya-bean (*Glycine max.*) which is grown under experimental conditions on the college farm, was used instead. Also *Paspalum virgatum*, a coarse vigorous grass, was tried instead of *Paspalum dilatatum*, as the latter is not recorded from the island.

Two methods, each depending upon the nature of the crop plant, were employed for keeping the thrips in confinement, once they were introduced.

For the larger plants a sleeve of strong muslin was used, the mesh of which, while permitting free aeration to the plant, was small enough to prevent the thrips from escaping. The sleeve, open at both ends, was placed around the branch or leaves to be infected, or in the case of the smaller plants, e.g., cassava, around the main stem. A wad of cotton wool was wound around the stem, the base of the sleeve placed round it, and a second wad of cotton wool wound over this, and tied firmly with twine. The thrips were then introduced, and the top of the sleeve tied up securely around a cotton wool plug. In cases where it was necessary, the sleeves were supported by means of stakes stuck in the pot. This method was most satisfactory, as it prevented the escape of the thrips, and did not damage the plant in any way or interfere with its photosynthetic processes.

In the second method, used for the smaller plants, i.e., cocoa seedlings *Mimosa pudica*, groundnut, rice, &c., the leaf or leaves to be infected were enclosed in a small glass jar, about two inches in diameter and six inches

long. The jar was fixed to a stake stuck in the soil of the pot, the jar tied at such an angle that the part of the plant to be enclosed entered it without any forced bending or strain.

After the thrips were introduced, a muslin square of the same type as was used in the previous method, was tied around the open end, enclosing the stem or leaf petiole. This was accomplished by cutting up the middle of one side of the muslin to the centre, and enclosing the two separate flaps around the stem. These were then drawn together one over the other, so that the remaining slit was obliterated, and the whole tied and gummed firmly to the neck of the jar. A small wad of cotton wool was gummed around the stem at its point of entrance through the muslin.

This method was also satisfactory in that if properly done, it prevented the escape of the thrips, and at the same time did not interfere with the photosynthesis of the plant.

The plants under experiment were kept from strong sunlight in an insectory with open sides. They were examined regularly, and opened when all the adults were dead, or when all the larvæ had either died or pupated. The controls of course were kept under exactly similar conditions to the corresponding crop plants.

As it was not found possible to breed sufficiently large colonies of thrips on *Clidemia* in pots, for the purposes of infection, *Clidemia* was collected from the bush, and from this material the thrips were taken and placed on the experimental plants. Recently emerged adults were used for the adult infections, and males and females were placed on the leaves in approximately equal proportions.

The number of thrips introduced depended on the amount of the food plant made available for them, or the sizes of the plant if wholly infected, a reasonably heavy infection being aimed at in each case. In their natural condition in Trinidad, never more than twenty-five thrips occur together under one leaf, or the petiole and stem adjoining it, the average number being far below this.

When introducing the thrips to the crop plants their natural position on the *Clidemia* was copied as far as possible; that is they were placed on the lower side of the younger leaves wherever this could be effected. In many cases they ran agitatedly up and down the leaves, with their tubes curled up over their backs in a characteristic manner, often crawling down the stem and on to the side of the sleeve or jar. In some cases this behaviour was continued for two or three days.

Those few larvæ which pupated often did so in the folds of the sleeve at its lower end, or on the muslin net, where it passed over the neck of the jar. In many cases the pupæ were small and abortive and died before moulting to adults. Only in the case of tobacco and *Paspalum virgatum*, where rather advanced larvæ had been introduced, were some pupæ successful in coming through to the adult stage.

At the conclusion of each experiment the leaves of the crop plant were examined carefully for any sign of damage that might have been done by the thrips. Only in the case of sugar cane, maize and groundnut, could any marks be discerned that might have been made by the attempted feeding of the thrips, and these were of such small dimensions as to be of negligible importance.

These marks took the form of small brown scarifications, on the upper surfaces of the leaves, and were only observed in the experiments with larvæ on the three crop plants concerned. In all other cases the thrips did absolutely no damage to the crop plants concerned.

After the conclusion of each experiment with adults, the leaves and other parts of the plant exposed to the thrips were very carefully examined under the binocular microscope. In no cases were any eggs of the thrips found.

The great majority of the dead bodies of the thrips were found in the sleeve or on the sides of the jar, only in a few instances were any to be seen on the leaves.

The controls were examined at the end of each experiment and in every case the thrips put on them were alive and healthy. Many of the larvæ had pupated, and eggs were laid on the underside of the top leaves in every case on controls infected with adults.

RESULTS.

The results are best summarized in the two following tables, one for the larvæ (Table I) and the other for the adults (Table II).

TABLE I.
INFECTIONS CARRIED OUT ON TWO PLANTS A AND B.

(Average day temp., 84° F.; night, 74° F.)

Material.	Number of thrips.	Date of infection	Date of last examination.	Interval of infection.	Remarks.	Control.
				days		
Coconut*	A 50	Feb. 4	Feb. 8	4	All dead	Healthy.
	B 60	Feb. 8	Feb. 13	5	All dead	Healthy.
Sugar cane	A 30	Jan. 29	Feb. 2	4	All dead	Healthy.
	B 30	Jan. 29	Feb. 2	4	All dead	Healthy.
Bananas*—						
Gros Michael	A 60	Mar. 8	Mar. 14	6	All dead	Healthy.
	B 50	Mar. 12	Mar. 18	6	1 pupated. Remainder dead. Pupa dead March 24.	Healthy.
Cavendish.....	A 30	April 24	May 1	7	All dead	Healthy.
	B 30	April 24	May 1	7	1 pupated. Remainder dead.	Healthy.
Pineapple*	A 25	Mar. 5	Mar. 14	9	All dead	Healthy.
	B 25	Mar. 5	Mar. 11	6	1 pupated. Remainder dead.	Healthy.
Cotton	A 25	Jan. 26	Jan. 30	4	All dead	Healthy.
	B 25	Jan. 26	Jan. 31	5	All dead. One dead pupa.	Healthy.
Mauritius bean	A 25	Feb. 28	Mar. 7	7	1 pupated. Remainder dead.	Healthy.
Bengal Bean (<i>Stizolobium deeringianum</i>)	B 25	Feb. 28	Mar. 5	5	All dead	Healthy.
Soy Bean* (<i>Glycine max</i>)	A 25	May 25	June 7	10	All dead	Healthy.
	B 25	May 25	June 7	10	All dead	Healthy.
Breadnut*	A 30	May 7	May 17	10	All dead	Healthy.
	B 30	May 7	May 17	10	1 pupated. Remainder dead.	Healthy.

* Infected by sleeve method.

TABLE I—continued.

Material.	Number of thrips	Date of infection	Date of last examination.	Interval of infection.	Remarks.	Control.
Sweet Potato	A 25	Jan. 24	Jan. 28	4 days	1 prepupa dead Jan. 30. Remainder dead	Healthy.
	B 25	Jan. 24	Jan. 28	4	All dead	Healthy.
Taro*	A 25	Feb. 21	Feb. 26	5	All dead	Healthy.
	B 25	Feb. 21	Feb. 26	5	All dead	Healthy.
Tobacco* (first expt.) ...	A 50	May 11	May 22	11	3 newly formed adults Remainder dead. Newly formed adults dead May 31. No eggs on leaf.	Healthy.
	B 50	May 11	May 22	11	2 newly formed adults Remainder dead. Adults dead May 30. No eggs on leaf.	Healthy.
Tobacco* (second expt.)	A 50	May 27	June 7	11	2 newly formed adults in A. 1 newly adult in B. Remainder dead. Newly formed adults dead June 11. No. eggs on leaf.	Healthy.
Yam*	A 25	April 26	May 6	10	1 pupated. Remainder dead.	Healthy.
	B 25	May 7	May 17	10	All dead	Healthy.
Para Grass (<i>Panicum muticum</i>).	A 25	Feb. 14	Feb. 18	4	All dead	Healthy.
	B 25	Feb. 12	Feb. 16	4	All dead. One dead prepupa.	Healthy.
<i>Paspalum Virgatum</i> *	A 30	June 8	June 21	13	2 newly formed adults in A. Two newly adults in B. Remainder dead. Adults dead June 24. No eggs on leaf.	Healthy.
	B 30	June 8	June 21	13		Healthy.
Rice	A 25	Feb. 19	Feb. 23	4	All dead	Healthy.
	B 25	Feb. 19	Feb. 23	4	All dead	Healthy.
Dhal* (Pigeon Pea) (<i>Cajanus indicus</i>)	A 25	Feb. 25	Mar. 1	4	All dead	Healthy.
	B 50	Mar. 2	Mar. 7	5	All dead	Healthy.
Groundnut	A 25	Feb. 27	Mar. 5	6	1 pupa. Remainder dead. Pupa dead March 8	Healthy.
	B 25	Feb. 27	Mar. 5	6	All dead	Healthy.
Cocoa	A 25	Feb. 16	Feb. 21	5	1 prepupa Remainder dead. Prepupa pupated Feb. 22. Dead Feb. 24.	Healthy.
	B 25	Feb. 16	Feb. 21	5	All dead	Healthy.

* Infected by sleeve method.

TABLE I—*continued*.

Material.	Number of thrips.	Date of infection	Date of last examination.	Interval of infection.	Remarks.	Control.
Para Rubber* A	30	May 7	May 17	days 10	2 pupated. Remainder dead.	Healthy.
B	50	May 8	May 17	9	All dead	Healthy.
(Tapioca) Cassava (<i>Manihot utilissima</i>) A	25	Jan. 30	Feb. 4	5	All dead	Healthy.
B	25	Jan. 31	Feb. 9	9	All dead	Healthy.
<i>Mimosa pudica</i> A	25	Mar. 16	Mar. 21	5	1 pupated. Remainder dead. Pupa died March 27.	Healthy.
B	25	Mar. 18	Mar. 25	7	All dead	Healthy.
Maize. A	25	Feb. 9	Feb. 15	6	All dead	Healthy.
B	25	Feb. 4	Feb. 9	5	All dead	Healthy.

TABLE II.

INFECTIONS CARRIED OUT ON TWO PLANTS A AND B.

(Average day temp., 84° F; night, 74° F.)

Material.	Number of thrips.	Date of infection	Date of last examination.	Interval of infection.	Remarks.	Control.
Coconuts* A	15	April 5	April 15	days 10	All dead	Healthy,
B	15	April 6	April 15	9	All dead	a few eggs.
Sugar cane* A	15	April 17	April 24	7	All dead	Healthy,
B	15	April 17	April 24	7	All dead	eggs.
Bananas*—						
Gros Michael A	15	Mar. 26	April 4	9	All dead	Healthy,
B	15	Mar. 28	April 6	9	All dead	eggs.
Cavendish A	15	April 16	April 22	6	All dead	Healthy,
B	15	April 16	April 22	6	All dead	eggs.
Cotton* A	15	April 23	May 1	8	All dead	Healthy,
B	15	April 23	May 1	8	All dead	eggs.
Bengal Bean A	10	Mar. 23	Mar. 30	7	All dead	Healthy,
B	10	Mar. 23	April 2	10	All dead	eggs.
Soy Bean* A	10	May 27	June 7	11	All dead	Healthy,
B	10	May 27	June 7	11	All dead	eggs.
Breadnut* A	15	May 8	May 17	9	All dead	Healthy,
B	15	May 8	May 19	11	All dead	eggs.
Sweet Potato A	10	April 8	April 16	8	All dead	Healthy,
B	10	April 23	May 1	8	All dead	eggs.

* Infected by sleeve method.

TABLE II—continued.

Material.	Number of thrips.	Date of infection	Date of last examina- tion.	Interval of infection.	Remarks.	Control.
Taro*	A 12 B 10	Mar 25 April 5	April 4 April 15	days 10 10	All dead All dead	Healthy, eggs.
Tobacco*	A 10 B 10	May 13 May 13	May 22 May 22	9 9	All dead All dead	Healthy, eggs.
Yam*	A 15 B 15	April 26 April 26	May 6 May 6	10 10	All dead All dead	Healthy, eggs.
Para Grass (<i>Panicum muticum</i>).....	A 10 B 10	May 2 May 2	May 11 May 11	9 9	All dead All dead	Healthy, eggs.
<i>Paspalum virgatum</i>	A 15 B 15	June 10 June 10	June 21 June 21	11 11	All dead All dead	Healthy, eggs.
Rice	A 10 B 10	April 25 April 25	May 3 May 5	8 10	All dead All dead	Healthy, eggs.
Dhal* (Pigeon Pea) (<i>Caja- nus indicus</i>)	A 10 B 10	Mar 15 April 6	Mar. 20 April 15	5 9	All dead All dead	Healthy, eggs.
Groundnut	A 10 B 10	Mar. 19 Mar. 19	Mar. 24 April 2	5 14	All dead All dead	Healthy, eggs and young larvae.
Cocoa	A 10 B 10	Mar. 20 Mar. 20	Mar 27 Mar 28	7 8	All dead All dead	Healthy, eggs.
Para Rubber*.....	A 15 B 15	May 9 May 9	May 21 May 17	12 8	All dead All dead	Healthy, eggs.
Cassava (Tapioca)*	A 12 B 12	April 20 April 20	April 29 April 29	9 9	All dead All dead	Healthy, eggs.
<i>Mimosa pudica</i>	A 10 B 10	May 14 May 14	May 24 May 24	10 10	All dead All dead	Healthy, eggs.
Maize*.....	A 12 B 12	May 10 May 10	May 20 May 20	10 10	All dead All dead	Healthy, eggs.
Pineapple*	A 12 B 15	April 27 April 27	May 6 May 6	9 9	All dead All dead	Healthy, eggs.

* Infected by means of sleeve.

It will be seen that all the larvæ died between four and thirteen days, those in the first instar dying sooner than those in the second. The interval for tobacco and *Paspalum virgatum* was longer than the rest as advanced larvæ were introduced, and the experiments were carried through until the newly formed adults were dead. In the case of tobacco the experiments were repeated with similar results.

All the adults died between five and fourteen days, the length of the latter in the case of one of the groundnut experiments, was due to one female which outlived the others by five days.

On none of the crops under trial were the females induced to lay eggs, but eggs were invariably laid on the corresponding controls.

CONCLUSIONS.

Since no eggs were laid on those plants infected with adults, that all adults died without doing any damage to the crop plants concerned, and that only previously well-fed larvæ pupated on them, it can safely be said that *Liothrips urichi* does not show any signs of adapting itself, either in the larval or adult stages, to any of the crop plants tried in the above experiments.

Those larvæ introduced just before their normal time of pupation, pupate on the crop plant and come through to the adult stage, but these die without laying eggs or feeding (e.g., tobacco, *Paspalum virgatum*).

Prepupæ and pupæ, as non-feeding stages of the thrips can give rise to adults when placed on plants foreign to it, but adults and larvæ, i.e., the feeding stages of the thrips, cannot exist on any plant other than *Clidemia hirta*.

Thus it seems that *Liothrips urichi* is specific with regard to its food plant *Clidemia hirta*, and would not attack any other plant in Fiji if introduced.

ACKNOWLEDGMENTS.

The writer's thanks are due to Mr. F. W. Urich for many helpful suggestions, and to Mr. A. Pickles for kindly criticism.

SOME NOTES ON PLANT ASSOCIATES AND HABITAT OF CLIDEMIA HIRTA (D. DON) IN TRINIDAD.

By W. Cook, B.A. (Cantab.).

Clidemia hirta is a Melastomaceous shrub 4-12 feet high. It occurs throughout Jamaica, St. Kitts, St. Vincent, Trinidad, Venezuela, i.e., its range is from Cuba and Mexico to Brazil and Peru.

It is very common in Trinidad, where it seldom exceeds five feet, and occurs in shady situations and on the edge of forests. In that island also the shrub is very generally attacked by *Liothrips urichi*, Karny, and it was during a study of these insects that the writer's attention was drawn to the habitat of the plant.

Clidemia hirta appears to prefer light shade, and it was never observed growing out in the open by itself, or invading cultivated areas exposed to sunlight. Typically, the plant occurs in two main habitats, both resulting from operations by man. A typical plant association including *Clidemia hirta* is seen where land previously cleared of virgin forest is left to lie idle, or where a previously cleaned, cultivated region is allowed to revert to bush. This association takes the form of vigorous bushes, and the land is completely covered by these, interspersed with a few trees.

The main bushes in order of importance are given in the following list:—*

Cordia cylindristachya, R.S. (black sage).

Lantana camara, L. (wild sage).

Psidium guava, Rudd. (the guava shrub).

Eupatorium cinereum, Gr. (a species of Christmas bush).

Gonzalea spicata, D.C.

Genipa americana, L.

Securidaca erecta, L.

Casearia ramiflora, V.

* See footnote to page 93.

Some bushes of *Eupatorium odoratum*, L. are generally to be found on the edges. Throughout this mass of bushes, scattered trees, generally a mixture of *Cecropia palmata*, W. *Acrocomia sclerocarpa*, Mart. (gru-gru palm) and a few *Mangifera indica*, are seen. *Clidemia hirta* is always found mixed with these bushes, generally as small shrubs, and taking the advantage of the shade caused by them. It is constantly associated in this environment with *Clidemia dentata*, D. Don, a shrub with pinkish leaves, and *Clidemia neglecta*, D. Don. These two species are always more vigorous than *Clidemia hirta*, when they occur together.

In these associations, which were observed on numerous occasions, the *Clidemia hirta* seemed to be kept down to small proportions by the overgrowth of the vigorous bushes of *Cordia cylindristachya*, *Lantana camara*, and *Eupatorium cinereum*, which would first strike the eye. The general attack of the thrips of course causes additional stunting.

The other marked habitat in which *Clidemia hirta* always occurs is along the banks of traces which are cut through cocoa plantations, generally on those winding up the mountains. It is very seldom found on narrow traces through original forest land, and it is never seen in the original forest itself. The plant along the sides of the bank are often cut low by cutlassing, but whenever they are allowed to grow *Clidemia hirta* is seen together with its plant associates. A typical bank of such a trace would contain the following flora.—Along the top there is generally a mixture of *Miconias*, chiefly *Miconia virescens*, *Triana*, and *Miconia acidodendron*, Sweet, together with species of *Centropogon*, and scattered species of *Olyra* grass.

In more exposed positions the tops of the bank are covered with *Eupatorium cinereum*. *Clidemia hirta* is always prominent along the sides, but it is never very large. It very seldom reaches more than three feet, and quite often is only a small plant. The following plants are its chief associates in this habitat:—*

Gonzalea spicata.
Clidemia dentata.
Stachytarpheta cayennensis, W.
Borreria laevis, Gr.
Borreria bartlingiana D.C.
Piper marginatum, Facq.
Solanum trichocarpum, Miq.
Coccocypselum nummularifolium, Cham. Schl.
Wulffia stenoglossa, D.C.

These plants would be found growing with ferns consisting of species of *Hemitelia* and *Blechnum*.

These two main habitats of *Clidemia hirta* were noted as a result of a few months empirical observation while collecting thrips.

In Trinidad *Clidemia hirta* is almost always seen in these two habitats. In the first it is relatively insignificant as compared with its other associates, and in the second it never grows to a large bush. Thus in that island it is of no importance agriculturally as a weed.

The writer is deeply indebted to Mr. W. Broadway of Trinidad who very kindly identified the plants named in the above notes.

* The above lists are not intended to be a complete list of plants that would be found in those particular habitats, only those are mentioned which are constantly seen occurring with *Clidemia hirta*.

COCONUT NOTES.

(From *Tropical Agriculture*, Vol. VI, No. 10.)

THE FLORAL BIOLOGY OF THE PALM.

THE advantages to be obtained from the use of planting material of known parentage, and the difficulties of obtaining such in the case of the coconut palm, have led several workers to investigate the sequence of events in the flowering of this crop, and the biology of its pollen, in the hope of establishing some practicable methods of controlling fertilization.

The latest contribution to the subject seen is an article by Maréchal ⁽⁶⁾ which adds some interesting details for Fiji to those previously published in Ceylon ⁽⁸⁾ the Philippine Islands ⁽¹⁾, and Malaya ⁽²⁾, ⁽³⁾.

EXPERIMENTS IN FIJI.

Maréchal (*loc. cit.*) used palms of the Malayan Dwarf coconut (introduced to Fiji), the Fijian Dwarf or *Niu Leka*, and the *Rotuma* variety. The Malayan Dwarf appears from his observations to behave in Fiji very much as it does in Malaya according to Jack and Sands ⁽³⁾. That is to say that the male phase of the inflorescence overlaps the female, and was never observed to end before the female phase began, so that natural self-pollination is possible in this variety. Maréchal, however, thinks on the basis of his experiments that self pollination is not the rule in Fiji, whereas Jack and Sands are definitely of opinion that in Malaya it is the rule. In the other varieties under observation the male phase was always found to finish from one to five days before the female phase began, and there was never sufficient overlapping of successive inflorescences to permit any self-pollination.

The period from the opening of the spathe until the first female flowers were receptive was found to vary from nine to thirty-two days in *Niu Leka* and from five to twenty-three days in Malayan Dwarfs.

Extensive tests were made of the viability of pollen under different conditions of storage, and a convenient method of pollen collection is described. Of the various media used for germinating the pollen to test its viability, the most satisfactory was 25 per cent. sucrose solution with 4.5 per cent. gelatine. The best storage results were obtained by keeping the pollen in full light in a desiccator over sulphuric acid of 30 to 40 per cent. strength. Under these conditions from 35 per cent. to 60 per cent. of the grains retained their vitality for at least 16 days.

Maréchal claims that one of his experiments demonstrated that "coconut pollen requires light to keep alive, and full daylight at that." This can hardly be taken on the published figures as well-founded without further proof. Pollen is capricious material to handle at all times, and safe generalisations about its behaviour can only be drawn from long series of experiments.

On the question of natural pollination, Maréchal agrees with other workers that both wind and insects play a part, but regards bees as by so far the most important pollinating agents as to be essential for high production of nuts.

It is not clear from the tables of results of pollinations that any controlled selfing with stored pollen was actually done, but artificial crosses were made with successes averaging about 30 per cent. and the technique used is described.

EXPERIMENTS IN TRINIDAD.

During the Session 1927-28, H. A. Pieris, a post-graduate student, carried out in the Botanical Department of the Imperial College of Tropical Agriculture a series of pollen tests similar to those of Aldaba (¹), Furtado (²), and Maréchal. The number of palms available for the work at the time was small, and the results, embodied in a Dissertation presented for the Associateship of the College, were not published. It now appears, however, that observations in Trinidad may be of wider interest for comparison with those in Fiji and elsewhere, and the following short account has been compiled from the Dissertation in the College Library in order to make them available.

The trees used were a group of eight, about nine years old, and of the common Trinidad kind. Pieris found that the interval between the opening of one spathe and the opening of the next varied from 25 to 37 days. The interval from opening of the spathe to receptivity of the first female flowers was from 19 to 24 days, and no case was observed of an inflorescence opening before the female phase of the preceding one was over, or of any overlapping of male and female phases in the same spadix. Cross-pollination is therefore apparently the rule in Trinidad.

To assess the relative importance of the natural pollinating agents, Pieris made an attempt to separate the effects of wind, crawling insects (red and black ants were the chief crawling insects noted on trees), and flying insects. The flying insects observed in inflorescences were *Apis mellifica*, *Polistes annulatus*, *Musca domestica*, and a small black beetle. These were easily excluded by bagging emasculated inflorescences with a rather wide-meshed muslin, which would not interfere seriously with wind-borne pollen, but the separation of wind and small crawling insects such as ants is less easy, and the method adopted, viz.: bagging with a very fine muslin bag tied loosely round the bottom of the spadix, cannot be claimed to be satisfactory, as wind-borne pollen was probably not entirely excluded.

Nevertheless, the results are of some interest. In waxed bags all flowers shed in a few days, but the dark, humid conditions inside the bags may have been as much responsible as the complete exclusion of pollen. In fine-meshed bags ten flowers set nuts out of 156 enclosed, or six per cent.; from general observations it is concluded that these were probably due to imperfect exclusion of wind-borne pollen, and not to ants. In coarse-meshed bags, out of 70 flowers enclosed, 22 set nuts, or 31 per cent. When emasculated inflorescences were left freely exposed, 42 flowers out of 108 set nuts, or 39 per cent.

Pieris concludes that wind pollination can only be as effective as it evidently was in this experiment, at fairly close quarters. This opinion he confirmed by repeating an experiment of Aldaba's, and exposing vaselined plates in different positions to catch wind-borne pollen. A plate exposed in the axil of a leaf on a tree adjacent to one which was shedding pollen at the time caught a few grains (the exact number is not stated) but in a second case where the source of pollen was two trees away, only three or four grains were collected in four days.

Fresh pollen was observed to contain a certain proportion of small and irregular grains, varying in different samples from 4 per cent. to 26 per cent. This agrees with Aldaba's findings, of abortive grains in proportions ranging from 3 per cent. to 33 per cent. in all the cultures he made. It may prove on further investigation to be a point of some importance.

The medium used by Pieris for germinating pollen as a test of viability was a sucrose solution made up freshly for each series of experiments, boiled

to sterilize it, and cooled before use. This was employed in hanging drop cultures. The optimum concentration was 25 per cent.—giving usually over 80 per cent. germination, with 20 per cent. and 30 per cent. sucrose not greatly inferior. As high a germination percentage as 14 per cent. was obtained in a 5 per cent. solution, showing that coconut pollen is fairly tolerant in its requirements.

Comparisons made between pollen stored over calcium chloride in a desiccator and pollen stored in gelatine capsules indicated that whilst the loss of viability after eight days was considerable in both cases, it was less in the gelatine capsules than in the desiccator. The best germination percentages on the eighth day were 49 per cent. for “capsule” pollen and 22 per cent. for “desiccator.” After this, however, the capsule pollen rapidly deteriorated, and gave germination (7 per cent. only) in only one set of experiments out of eight on the 16th day, and none at all on subsequent dates. Desiccator pollen, on the other hand, although rather erratic, continued to give small percentages of germination until the 31st day. The best samples gave 34 per cent. on the 16th day, 15 per cent. on the 18th day, 9 per cent. on the 27th day, and 4 per cent. on the 31st day.

Artificial pollinations were carried out both with fresh pollen and with stored pollen. Fresh pollen set six nuts from 38 flowers pollinated, pollen kept seven days in a gelatine capsule set two nuts from 11 flowers, and pollen kept seven days in a desiccator set three nuts from 14 flowers. These numbers are admittedly small, and it is unfortunate that it was not possible at the time to test pollen stored for longer intervals, but the figures are quoted because in the third case mentioned the three nuts were set with pollen from the same inflorescence, collected before the male flowers shed. The possibility of artificial selfing of coconuts in Trinidad was thus definitely established.

GENERAL CONSIDERATIONS.

As there are now several accounts of the floral biology of the coconut palm in different parts of the Tropics available for comparison, it may be useful if a short summary is given here of the state of knowledge to date.

Production of inflorescences.—The average rate of spadix production is sometimes stated to be about one per month, and this may perhaps be used as a rough rule, but there is so much variability that a general average based on several sets of observations in different places can be of little value.

The shortest average interval between successive inflorescences yet recorded is 20 days, for dwarf coconuts in Malay ⁽⁵⁾, and it would be interesting to know whether this variety is genetically different from tall kinds in this respect, but there is no record available of any comparisons between the two types under similar conditions. In an earlier paper ⁽³⁾ based on observations of a different set of dwarf palms (which, by the way, are described as “not well cared for”) the same authors give a table from which the average interval works out at 24 days, and this is not significantly different from the average interval of 25 days calculable from one of Aldaba’s tables for two tall palms in the Philippines.

Such difference in behaviour between two sets of palms of the same variety may fairly be adduced as evidence of a general effect of environmental conditions, and perhaps even stronger evidence is afforded by the remarkable variations in interval exhibited by any single palm in the course of a few months. Petch ⁽⁸⁾ for example, observing one palm at Peradeniya, found intervals ranging from 24 to 58 days. This example is selected from many available because Petch notes that the longest interval occurred in the driest months, whilst the month of the shortest interval (May) is usually

hot and moist at Peradeniya. He adds, however, that in general the intervals are not governed only by rainfall.

The relationship of spadix production to general growth conditions does not appear to have been anywhere worked out in detail, but from the observations of Mason and Lewin on the Oil Palm in Nigeria (7) and from consideration of the fact that there is normally a spadix in every leaf axil, we should expect the rate of flower-bud formation to be determined by the same factors as the rate of leaf formation, whilst the later development and opening of the inflorescence are likely to be governed by additional factors.

Number of female flowers per spadix.—All investigators report wide variability in this character, Furtado putting the extremes at zero and three hundred, whilst Sampson (10) records having counted up to 235. No data have been found which show how much of this variation is due to genetic differences between palms, but the evidence for seasonal fluctuation is abundant.

Maréchal records a tendency for Malayan dwarf coconuts in Fiji to produce more female flowers in the inflorescences which open from November to March than in those opening during the rest of the year, and there are similar notes in other papers. The most detailed record is that of Sampson, who gives a graph showing very definite seasonal fluctuation on the Malabar Coast of India, and suggests a correlation with climatic conditions which in broad outline is probably correct. More detailed work still, based on an exact determination of the length of time which it takes for the bud to develop from its first initiation, would probably disclose some interesting features of the physiology of the palm, with an obvious bearing on the question of final yield.

Percentage of flowers forming mature nuts.—This probably depends upon three sets of factors, viz.: (1) the genetic constitution of individual trees (2) the conditions governing pollination and (3) the general condition of the trees at the time.

So far as the first set of factors is concerned, we know from the work of Jack (4) that individual palms possess an inherent capacity for high, low or medium bearing, and it seems reasonable to suppose that inherent capacity for high, low or medium setting of fruit may be one of the causes contributing to final yield, but we have no information more definite than a statement by Sampson to the effect that some trees never produce a large number of female flowers, but at the same time set a high proportion of them, with the result that cropping is relatively steady, whilst other trees are very irregular in bearing.

The general condition of the tree, and its relationship to the fall of immature nuts after these have been properly pollinated, does not properly belong to our subject, and the conditions governing pollination demand a separate heading.

Conditions governing pollination.—The question of prime importance to the coconut breeder, and one which has been widely discussed, is whether the palm is normally self- or cross-pollinated. This question may be simplified at the outset by removing from the discussion the dwarf coconut of Malaya, which has been shown fairly conclusively by Jack and Sands to be chiefly self-fertilized in Malaya, and by Maréchal to have at least the potentiality of considerable natural selfing in Fiji.

From the sum of observations on other types, it is quite clear that cross-pollination is the general rule, but opinion still varies about the amount of self-pollination that may take place. In some localities the latter method appears to be entirely ruled out, whilst in others the case is different. Self-pollination, when it does occur, may result from overlapping of the male and female phases of the same spadix, or, probably more commonly, from overlapping of the female phase of one spadix with the male phase of the next on the same tree. The points of importance therefore are the interval between inflorescences, the onset and duration of the male phase, and the onset and duration of the female phase. The indications are that each of these is affected by environmental conditions. Warmth and humidity appear to accelerate the onset of the phases, perhaps especially the female phase, so that in the lowlands of Malaya, for example, this phase may begin before the male ends. On the other hand, a lower humidity favours the retention of vitality by the pollen, so that there may sometimes be the possibility of female flowers being fertilized by pollen from male flowers of the same inflorescence which have already dropped.

Accepting cross-pollination as the rule, we come next to the question of the pollinating agents. Here there is general agreement that both wind and insects play a part, and that wind is only effective at fairly short range. Further, there is a striking similarity between the lists of insects observed visiting the flowers in different parts of the world. All observers place bees at the head of the list in importance and add other Hymenoptera; nearly all report the common house-fly or a closely allied species, and several add at least one species of beetle but assign little importance to it.

Artificial pollinations.—From what has been said, it will be evident that any attempt to control the parentage of seed nuts must involve protection of the flowers against foreign pollen. This means that the spadix must be emasculated and bagged, and a bag which safely excludes all possibility of contamination by wind-borne pollen may be rather unfavourable to the setting of nuts. Possibly this accounts for the rather poor results obtained by some workers with artificial pollination. Apart from this, there is no difficulty in making crosses if the desired pollen is available, but if self-pollinations are required, or if the right pollen for a cross is not available at the right time, recourse must be had to storage.

Keeping qualities of pollen.—Taking the results of all investigators together, it is clear that under some conditions coconut pollen will keep for about a week without any special precautions. The length of its life, however, may be greatly increased and rendered more certain by controlling the humidity of the atmosphere, which is probably the most important factor. In an atmosphere saturated with moisture, the grains lose their viability in a few hours, whilst at the other extreme of humidity the majority lose their viability over calcium chloride rather faster than undesiccated grains, though a few remain alive for at least a month. The optimum condition lies between the two, and the best results for practical purposes are those of Maréchal, who, as mentioned above, obtained germinations of 35 per cent. to 60 per cent. after sixteen days by storing over 35 per cent. sulphuric acid.

Pollen culture.—Even under careful conditions of storage, pollen will always vary and it is therefore necessary to test samples before use. This can be done by germinating the grains in a sucrose solution, and the optimum concentration has been found by several to be 25 per cent. although germination is obtained in all concentrations from 5 per cent. to 30 per cent.

In conclusion, it may be stated that the best results to date, whilst serving immediate practical purposes, are sufficiently irregular to indicate a need for still further investigation of the biology of coconut pollen.

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SOIL EROSION.

(From *The Empire Cotton Growing Review*, Vol. VI, No. 4.)

A VERY interesting address upon the development of tropical countries was delivered at the annual meeting of the Empire Cotton Growing Corporation by Mr. Stockdale, the Assistant Agricultural Adviser of the Colonial Office. His observations were of such importance in their bearing upon the future of our tropical and sub-tropical Empire that they should be closely studied by all who hope that that future will be full of steady progress and prosperity.

Among the important subjects which were brought up in the address, and with which we may perhaps deal at various times, was that of soil erosion, which plays a larger role than is always clearly understood. People who have not seen the rain fall in the tropics, especially in the monsoon countries that include so large a part of the Empire, are apt to picture it as something like the rain at "home." Our rain, however, except upon rare occasions, would be regarded there as gentle drizzle.

If in England one clears a piece of land, the rain undoubtedly begins to wash it away, and to leach it, but at a rate that is hardly worth mentioning beside that which occurs in the tropics. There, a shower in which a whole month's English rain falls in a few hours is a common occurrence, and we have ourselves seen 10 inches of rain fall without a break in less than a day. Such rain rapidly washes away the surface soil, and leaches out the lower layers, so that in a few years after clearance the richest forest land may be reduced to the poorest possible condition.

The natural state of most of the land in the rainy countries of the tropics is to be covered with forest or coarse grass. In either case it is useless for general agriculture, but its soil is at the maximum degree of content of humus, plant food and water-retaining capacity (largely due to the humus) that occurs under natural conditions. These features—which, as everyone who works with agriculture in the tropics knows, soon diminish and largely disappear after clearance of the land—are the natural capital of the country. This capital should be conserved, not regarded—whether consciously or unconsciously—as something to be exploited until perhaps the land at the last must be abandoned (as one may see in many places). The real question is, how to get the best out of the land without destroying the natural capital more than can be helped.

It is possible to live almost entirely upon the capital value of forest land, and this is the underlying explanation of the type of cultivation known in Ceylon as *chena*, in India as *jhuming*, in Malaya as *ladang*, and by other names in other countries. It is found almost all over the world where population is thin enough to allow to each person a large area of forest land. The trees on a portion of this are felled and burnt, and on the rich forest soil, further improved by the ash, a couple of crops of cereals or other products are grown, and the land is then left to go back gradually to forest: it is again good enough to *chena* in ten to fifty years.

This is living upon capital purely and simply, for the land is abandoned as soon as it begins to become weedy, in order to avoid the labour of real cultivation. It is less trouble to *chena* a fresh piece of land. If population increase, however, as it has done for example in much of India and Ceylon, *chena* must perforce be given up and more real cultivation carried on. But this has, in such countries, to be done upon land where the natural capital, owing to reckless clearance, has been very much reduced. The result is poor and uncertain crops, varying considerably with the climate of the particular year.

In districts where the people are more intelligent, or perhaps, to be more exact, where pressure of population has compelled them to take more care, one may see attempts being made to rectify this state of things, by green manuring, rotation of crops, mixture of crops, and even by the use of actual manures, though, in general, cowdung, which is almost the only available and cheap manure, is used as fuel, and so is largely lost. But there are distinct and recognizable attempts to put back something into the soil, or to equalize and minimize its rate of loss.

A state of things which is essentially very similar to this may be seen in most tropical regions opened up by Europeans in coffee, tea, &c. Largely through ignorance, they have used up the natural capital of soil, humus, &c., almost as rapidly as possible. Their planting of various crops has largely proceeded in "booms," in which there has been an insistent demand for land, and not sufficient foresight or knowledge on the part of the Government to curb this demand in the interests of future generations.

The result has been wholesale opening of land, usually in hilly country, where erosion proceeds more rapidly. The heavy rainfall has caused tremendous erosion and leaching, and has led to the silting up of rivers, causing floods and stoppage of navigation. A heavy price has frequently to be paid by a country that has been opened up for planting—not so much at the time, as later, when results of the mistakes that were made in earlier times begin to appear.

Just as with the native industries above mentioned, so the planting industry has been forced to resort to the use of manures, of green manures, of terracing to prevent wash, of drainage, and so on. But the Government can and should also assist, for example, by the provision of sufficient reserves of forest. In Ceylon, in early days, small strips of forest were left along the tops of the ridges, but they were so narrow that they were soon consumed for firewood, burnt, or otherwise rendered nugatory. However insistent be the demand for land, the Government should enforce the reservation of large areas in forest, in such a way as to prevent erosion (so far as possible), or the drying up of the streams in hot and dry weather, a common occurrence in such countries as Ceylon, where it adds greatly to the difficulties of water supply.

The provision of an officer for general service in the tropical and sub-tropical colonies, to deal with this whole question of prevention of erosion

and of deterioration of soil, is quite worth the consideration of Government. But if appointed, he should spend a good deal of time in study both within and outside of the Empire, to see how the matter is dealt with, for example, in Java by terracing, &c., in China and Japan by the use of manure, &c., and in other countries in other ways. He should establish liaison with forest and irrigation officers, with engineers in charge of roadmaking, and others, and eventually with their assistance devise definite schemes for road, drainage, and forest reservations, and for all such matters which concern several departments (and which must therefore be carried out by definite orders from Government headquarters), in addition to working at the questions of manuring, green manuring, &c., which are the province of an agricultural department.

Nearly all countries which have been opened up for any kind of "planting" afford striking object lessons in what ought *not* to be done, and the newer colonies should profit by these lessons before it is too late, and should learn what *ought* to be done, and do it.

FULL SCOPE FOR AGRICULTURAL IMPLEMENTS AND MACHINERY.

(From *The Implement and Machinery Review*, Oct., 1, 1929.)

When every rood of ground maintained its man.—Goldsmith.

IT is quite clear in "The Deserted Village" Oliver Goldsmith was trying to point the moral of what has since been the substance of most "back-to-the-land" movements. Intensive tillage of the land by manual labour, with every rood worked to the uttermost, may have been an ideal in the days of long ago, but nowadays the idea that men have only to return to the land in great numbers and work it most laboriously to be successful and to restore the economic equilibrium of the country, is being rapidly exploded. Two recent Canadian references on that point come most opportunely, as it is convincingly shown in both of them that to parcel out the country into so many "cabbage patches"—a term of disparagement that is permissible because it is so aptly expressive—is, under present conditions, most retrogressive. Intensive hand labour, which is the *sine qua non* of the successful working of any small holding, is the most expensive form of performing farm operations, and current tendencies are all in the direction of showing that, far from it being necessary to place greater or increased dependence on hand labour, the demands of the times are that less and less assistance of this class shall be required. Hand labour everywhere is dearer than mechanical work when the latter is afforded full scope for application, and therefore it is held to be the negation of all progress to suggest, as has been suggested in some quarters, that the ideal would be to carve up all the big estates and holdings and hand them over to various individual workers for more intensive cultivation. But that suggestion we can briefly dismiss as the ideal of a certain school of political faith. The ideal from an agricultural point of view is that the less hand labour there is required for a specific operation, the more likely are costs going to be cut, and that is why there is a decided leaning to-day, even in this country, (England) towards larger farms and freer use of modern implements and machinery, with the bigger outfits looked upon with greater favour if their acquisition is justified by the size of the estate. We know of several farmers who are contemplating important steps in this direction; in which case a rood of ground will not maintain a man in the sense of our quotation, but will be merely a small factor in a comprehensive whole. Indeed, the

temper of much farming opinion which we have come in contact with lately, is that farms are already too restricted without any question of further parcelling out, and that it is time some of the hedges and other natural and unnatural dividing lines between field and field were swept away to give full play to the labour saving implements and machines now available. The feeling is ably expressed by a correspondent to *The Times*, when dealing with the subject from another angle, viz, that of farming in Canada. "It is," he says, "an elementary economic fact that the overseas farmer competes successfully with the European farmer simply because he can work on extensive and not intensive lines," and to show that this is no mere play upon words, the same authority remarks that a Canadian farmer can make a profit out of a 20-bushel crop when the English farmer cannot do so with one of 30 bushels. The explanation, as is confirmed by a Bulletin prepared by Mr. W. C. Hooper (of the Central Experiment Farm, Ottawa), and published by the Dominion Department of Agriculture, is that "on of the important means of reducing the cost of producing crops, and thereby enlarging the profits from farm enterprise, is to increase the daily amount of work performed per farm worker." And this can only be done, we believe, by the efficient application of modern farm implements and machinery.

HOW THE USE OF IMPLEMENTS AND MACHINERY BECOMES MORE
ECONOMICAL.

For when was power beneficial in vain?—Johnson.

To appreciate the truth of the argument in favour of implements and machinery working land intensively and cheaply against the old and effete system of sweating man power, it is only necessary to call one or two instances from the report published by the Canadian authorities. It is shown, as a case in point, that whereas a one-furrow plough hauled by two horses and guided by one man can plough something like 1.33 acres of sod or 1.58 acres of stubble daily, a tractor and a three-furrow plough requiring one more man-power, can cover 6.85 and 7.73 acres in the respective categories. These are the two extremes given in this official report, for a two-furrow plough and tractor outfit returns 4.81 and 5.51 respectively, which strengthens the argument in favour of the most intensive use of mechanical outfits in their highest form of expression. As ploughing is acknowledged to be the most expensive operation in the preparation of land for seeding, the exact outcome of the substitution of modern methods for the older ones can be readily estimated if not precisely measured. The same remarks apply in the case of other classes of work. Two horses with a single disc harrow cover 7.47 acres per day, and with a double disc, 6.18. Compared with this a tractor of what is termed three-plough capacity can cover 20.37 and 19.93 acres respectively. Harrowing and land rolling with two horses are given at 11.47 and 13.79 acres respectively, whereas, it is well known that such work with tractors exceeds these returns by really extraordinary margins. Nor must it be overlooked that the experiments of the Canadian authorities have established that in planting, harvesting and kindred operations, the application of the best mechanical means has proved to be the most advantageous, particularly in the direction of economy. Any talk, therefore, of cutting up large estates and dividing them out, while doubtless very solacing to certain political individuals, cannot be justified on the evidence of the day, for what has been proved to apply in Canada is being daily found to be applicable to all countries where labour charges are shown

to be a severe burden at a time when the actual rate of pay for labour is as low as decency will tolerate. The remedy, therefore, is to make labour more profitable by applying it differently, *i.e.*, with the aid of more machinery, and once that is done intelligently, agriculture everywhere will not have such a cadaverous appearance.

EFFECT OF METALS ON MILK.

(From *Queensland Agricultural Journal*, Oct. 1, 1929.)

AN interesting and important paper on the effect of various metals on milk and milk products by Professor Hunziker was read in the course of the recent World's Dairy Congress week in London.

The investigations involved a study of the resistance to corrosion of nineteen different metals—plated metals and metallic alloys—to the action of sweet and sour milk and cream; of the individual organic acid contained in milk and cream; of numerous washing-powders and chemical sterilisers; and of sodium and calcium brine. The investigation included the effect of these metals on the flavour and physical properties of the milk and milk products. The following conclusions have been arrived at as a result of the investigations:—

1. Zinc, iron, galvanised iron, and copper proved utterly unsuitable metals for dairy factory equipment. They not only corroded profusely, but developed in the milk product objectionable flavours with unfailing regularity. These off-flavours were chiefly of the metallic flavour character. These tests emphasise the fact that much of the metallic cream that arrives at the creameries is due to rusty cream cans, and that the preservation of the tin coating on the inside of the can is an exceedingly important factor in controlling the quality of the cream.

2. Nickel silver, Monel metal, and poorly-tinned iron also injured the flavour of the milk, though the flavour defect was not so pronounced, and the loss in weight due to corrosion, while considerable, was not as great as in the case of the metals under Group 1. These metals are unsafe for use in the construction of milk plant and creamery equipment. Monel metal proved somewhat more resistant to corrosion and less damaging to the milk product than nickel silver.

3. The ordinary chromium steels, such as Ascoloy and Enduro, and also aluminum and aluminum manganese alloy, proved quite resistant to corrosion, and in most cases harmless to the milk product. Ascoloy and Enduro, however, while resistant under most conditions up to a certain point, pitted and rusted freely under severe conditions. Enduro showed somewhat greater resistance than Ascoloy. This suggests that these ordinary chromium steels are not safe alloys to use in dairy factory equipment.

Pure aluminum had no appreciable effect on any of the milk products excepting very sour milk, such as acidophilus milk, in which it developed a slightly metallic flavour. Likewise, its resistance to corrosion, excepting in the presence of alkalis, was generally good. The greatest weakness of aluminum is its high corrosiveness in contact with alkalis, such as are contained in the washing-powders and in alkaline brine. In the case of sodium carbonate and sodium brine, the resistance of aluminum may be very greatly augmented by the addition of a small amount of sodium silicate. Aluminum is being used advantageously in European factories for milk storage tanks and milk shipping cans.

4. Nickel, tin, and properly tinned copper carried no noticeable off-flavour in the milk product, and their loss in weight due to corrosion was comparatively small. These metals, while also slightly soluble in lactic acid, may be considered safe metals for use in milk plant and creamery equipment as far as their effect on the flavour of the milk product is concerned. The tin proved more nearly completely inert than the nickel, which tarnished readily and caused a slight off-flavour in acidophilus milk.

5. Allegheny metal, which is a special chromium-nickel-steel alloy, proved superior to any of the other metals studied. It had no effect on the flavour of any and all milk products, and it suffered no loss in weight, and showed no visible signs of corrosion in organic acids, sweet and sour milk and cream, alkaline washing powders, and brines. This alloy promises to play an important role in the construction of our future dairy equipment.

6. The presence of two or more metals in the same piece of dairy equipment is fundamentally undesirable. Most metals used may differ in their electrical potentials, and this in turn invites corrosion and impairment of flavour by electrolysis. For similar reasons impurities in metals, as for instance, impure aluminum, such as cast aluminum, also copper alloys and imperfectly tinned iron and copper, are equally unsatisfactory.

CONTROL OF WEEDS ON LAWNS.

(From *Queensland Agricultural Journal*, Oct. 1, 1929.)

WEEDS in lawns and on bowling and golf greens cause considerable annoyance and trouble, and are often difficult to control, especially if proper precautions have not been taken from the outset. As a rule, most trouble is experienced on lawns and greens which have not been properly drained, or which are shaded, or where the soil has not been enriched before laying down the grasses. It is obvious, therefore, that control of weeds in such places must be kept in view from the time that the lawns are being established.

In the case of bowling-greens and golf greens special care should be exercised to see that they receive direct sunlight throughout the whole of the day, particularly during the winter months, and also that they are thoroughly drained by means of agricultural drain pipes placed below the ground. The soil should also be enriched either by adding a better class of soil or by heavy dressings of well-rotted animal manure. If these precautions are adopted and high-grade seed, free from weed seed, is sown thickly, little trouble will be experienced from weeds. Subsequently, a vigorous growth of the grass should be encouraged by frequent watering and by top-dressing with well-rotted animal manure composted with soil.

When such dressings are being made, care should be exercised to see that all weed seeds have been destroyed in the compost. This can only be done by composing the soil and manure in heaps which can be kept under observation for some months. If it is not possible to ensure that the composts are free from weed seed, it is preferable to use artificial fertilisers for top-dressing.

Despite the greatest care that is taken, however, weeds will occasionally appear in lawns, and they must be immediately hand-pulled. If care is exercised in this direction, no great difficulty will be experienced in keeping the weeds under control. Clover is often troublesome in lawns, and this can be checked to some extent by top-dressing with sulphate of ammonia, which does not encourage the growth of clover, but stimulates the growth of grass, which checks the clover.

Superphosphate and lime should not be used on lawns which are likely to be infested with clover, as they stimulate the growth of clover.

Chemical exterminators cannot be recommended to any extent for control of weeds on lawns, but they can be used, particularly arsenic preparations, for killing individual plants such as *paspalum* grass. A little of the preparation should be dropped on the middle of the plant.

FIJI LIVESTOCK RECORD ASSOCIATION.

MINUTES OF SPECIAL GENERAL MEETING HELD ON OCTOBER 15, 1929.

THE following were present:—Superintendent of Agriculture, Acting Senior Veterinary Officer, Hon. A. Barker, Messrs. J. L. Hunt, G. Kiss, J. Barber, R. Barber, A. H. Witherow, L. N. Bean, R. Craig, A. S. MacKenzie, J. A. Garnett and A. B. Ackland.

The Superintendent of Agriculture stated that he had called the meeting with a view to re-forming the Association, which had ceased to function, and that, if the meeting decided that a Livestock Record Association was necessary, he would do everything in his power to make such an Association a success. He appealed for the support of all stock owners. The gentlemen present signified their approval of the objects of the meeting.

The minutes of the inaugural meeting of the Association and of a meeting of the Directors, held on the 7th September, 1927, were read by the Secretary who outlined the action taken thereunder.

A motion, "That the Fiji Livestock Record Association to be re-formed as from to-day," proposed by Mr Barker and seconded by Mr J. L. Hunt, was carried unanimously.

It was resolved that the meeting be regarded as the first General Meeting of the re-formed Association.

Mr. Barker proposed and Mr. Witherow seconded a resolution that the subscriptions be remitted for the balance of the year 1929, but that, as soon as the subscription rates had been decided upon and approved, the Secretary should proceed to collect them in respect of the year 1930.

The Superintendent of Agriculture appointed Mr. A. B. Ackland to be Honorary Secretary of the Association.

The following gentlemen were elected by ballot to be Directors of the Association:—G. Kiss, Esq., R. Craig, Esq., and J. Barber, Esq.

The meeting then considered certain matters with a view to indicating to the Directors the wishes of the members.

It was decided to recommend the Directors to take action as follows:—

- (a) To seek approval for the use of the *Agricultural Journal* as the official organ of the Association, in which would be published the Rules. The Superintendent of Agriculture said that amendments to rules, owners and names of animals registered (without pedigrees) and reports of meetings, could be printed from time to time. A list of members and the Annual Report of the Association would be printed once a year. The journal might also be used for advertisements at standard rates of stock for sale and sires available for service.
- (b) To amend the Regulations so as to provide for the payment of fees on the following scale:—

Subscriptions.

Life membership	£5	5	0
Annual membership	0	10	0

*Fees for Registration, &c.**Members—*

First male	0	5	0
First female	0	3	0
All subsequent registrations, each	0	1	0
Transfers, each	0	2	6
Prefix or suffix, each	0	5	0
Regulations, &c.	0	1	0

Non-members—

Male animals, each	0	5	0
Female animals, each	0	3	0
Transfers, each	0	2	6
Prefix or suffix, each	0	5	0
Regulations, &c.	0	1	0

- (c) To amend Regulation 35 so as to provide for the exemption from the provisions of that Regulation of all stock imported prior to the 31st December, 1929.

Mr. Stuchbery stated that Sir Henry Scott and Messrs. D. Costello and G. C. Foulis had signified their intention of becoming members of the Association.

Mr. Witherow referred to the practice of all Friesian Associations of requiring photographs of animals to accompany applications for registration. The meeting decided that the Regulations should include provision for this procedure.

FIJI LIVE STOCK ASSOCIATION.

MINUTES OF MEETING OF BOARD OF DIRECTORS HELD ON OCTOBER 24, 1929.

THE following were present:—Superintendent of Agriculture, (Chairman), Acting Senior Veterinary Officer and Messrs. R. Craig, J. Barber and G. Kiss.

Amendments to Regulations.—The Board directed that the Government should be requested to amend the Regulations made under the Live Stock Record Association Ordinance, 1927.

Branding of Cattle.—After some consideration of Regulations 42 and 47, which refer to the branding of animals registered in the Herd Book, it was decided not to make any amendment to these Regulations.

Seal of the Association.—The Chairman was authorised to procure a rubber stamp to serve as a Seal as provided for in Regulation 27.

Association's Brand.—The Board directed that the brand of the Association should be \wedge provided that such Brand was not already registered. The Secretary was instructed to register the Association's Brand under the Brands Ordinance 1927. The Board further directed that owners of stock should be permitted to brand registered animals on such conspicuous parts of the body as they should desire.

Date of Annual Meeting.—The date of the Annual General Meeting was fixed for the sixteenth day of January, 1930.

Enrolment of Members.—The Secretary was instructed to approach stock owners in regard to joining the Association, as soon as the proposed amendments to the Regulations had been made.

FIJI LIVE STOCK RECORD ASSOCIATION.

REGULATIONS.

1. The constitution and regulations of the Association shall be as follows:—

NAME.

2. The Association shall be "The Fiji Live Stock Record Association."

OBJECTS.

3. The objects of the Association shall be—

- (a) to keep a record of the pedigrees of pure bred domestic animals of distinct breeds;
- (b) to collect preserve and publish data information and documents relating to pure bred domestic animals; and
- (c) to encourage the breeding of pure bred domestic animals in whatsoever way the Association may see fit to do.

MEMBERS.

4. There shall be three classes of members:—

(a) *Honorary Members.*

The Association at a general meeting may appoint honorary members but such honorary members shall take no part in the management of the Association's affairs. Provided however that honorary members may take part in the proceedings at a general meeting and vote thereat if a majority of all other members present so decide by resolution and provided further that such honorary members had been appointed at the time notice was given calling the said meeting.

(b) *Life Members.*

Life members shall be those resident in the Colony who have paid a fee of £5 5s.

(c) *Annual Members.*

Annual members shall be those persons partnerships or incorporated companies resident in the Colony who pay an annual membership fee of 10s. on or before the thirty-first day of January in each year in advance. Persons resident outside the Colony may become life or annual members of the Association provided their applications are approved by the Board.

5. Applications for membership shall be in writing and each applicant shall agree to be bound by the constitution and amendments and all regulations of the Association.

6. All members shall as a matter of contract and except as hereinafter provided enjoy the same rights and privileges and be subject to the same liabilities as if each had signed the application for incorporation of this Association or this constitution as amended from time to time. No member who is in arrears for membership or other fees or dues shall enjoy such rights and privileges.

7. Any member may provided he is not in arrears for membership or other fees or dues at any time withdraw from and terminate his membership in the Association by giving the secretary one month's notice in writing of his intention so to do.

8. If any member shall be in arrears for membership or other fees or dues for a period of six months the Board may terminate his membership

in the Association by resolution a notice of which shall be mailed to him at his last known post office address as on record in the books of the Association but any member whose membership is so terminated shall not again become a member unless arrears owing at time membership was terminated are paid.

9. Each member of the Association shall receive free of charge publications which are issued during each year of his membership for which he has paid the membership fee.

10. No member shall hold office or be entitled to vote at a meeting if at the time he is in arrears for membership fees and no member shall be entitled to vote who was not a member of the Association at the time notice was given calling such meeting.

11. The Board shall have power to suspend any member who fails to observe any regulation of the Association or whose conduct in their opinion is prejudicial to the Association. Such suspension shall be reported to the next general meeting and the Association may by the affirmative vote of a majority of those present at a general meeting expel such member from the Association.

12. No person expelled shall thereafter be eligible for membership until his reinstatement has been recommended to a general meeting by the Board and such general meeting shall reinstate such member only by the affirmative vote of two-thirds of the members present and voting thereat.

13. Any person expelled from membership of any other association for the improvement of pure bred domestic animals shall be ineligible for membership in this Association and if he is a member at the time of such expulsion his membership shall thereupon forthwith terminate automatically.

OFFICES.

14. The head office of the Association and the office for the registration of pedigrees shall be at the office of the Superintendent of Agriculture in Suva.

FISCAL YEAR.

15. The fiscal year of the Association shall correspond with the calendar year.

OFFICERS.

16. There shall be a Board of Directors of the Association of whom the Superintendent of Agriculture shall be chairman and the Government Veterinary Officer nominated by the Governor an *ex officio* member. In addition there shall be elected by ballot at the first general meeting of the Association three directors to hold office during two years who shall be eligible for re-election at the end of the same period of two years when a fresh election shall be held at a general meeting and in like manner every two years. The Secretary shall also act as treasurer and registrar of the Association. He shall attend all meetings of the Association or the directors and keep minutes of the proceedings. He shall conduct all head office correspondence and prepare reports. He shall give notice of all meetings of the directors of the Association receive all moneys of the Association and deposit the same in a Bank in Suva and pay the same out again by cheque counter-signed by the Superintendent of Agriculture. He shall keep proper books of account and shall keep the pedigree register of the Association and enter therein all pedigrees and transfers in such form as may be determined upon and perform any other work or duties in connection with the Association as may be determined by the Board.

PEDIGREE COMMITTEE.

17. The Chairman and the Government Veterinary Officer serving on the Board shall form a pedigree committee who shall have power to adjudicate all questions of transfer of ownership or eligibility for registration. Their decision in so far as the records of the Association are concerned shall be final but shall not affect any other right or liability in a court of law.

AUDITOR.

18. The Association at each annual general meeting shall appoint an auditor and fix his remuneration. His duties shall be to examine the books of account of the Association vouchers for all payments and present a report thereon at the next annual general meeting.

MEETINGS.

19. There shall be held an annual general meeting at such place and time as may be fixed by the Board. Notice by letter posted to each member's last known address shall be despatched at least thirty days before the date of such meeting.

20. The Board shall meet at least once in every three months at such time and place as the Chairman shall direct. Notice shall be given to the directors by letter despatched at least ten days before the date of such meeting.

21. A meeting of the Board may be held on shorter notice with the consent of a majority of the directors.

22. For the transaction of the business of the Association at an annual or other meeting a quorum shall be seven. At a meeting of the Board a quorum shall be three.

AUDIT.

23. The Board at each annual meeting shall submit a complete report of its acts and of the affairs of the Association; it shall present a detailed statement duly audited of the receipts and payments of the preceding year and of the assets and liabilities of the Association.

RECEIPTS AND PAYMENTS.

24. The income and property of the Association from whatever source derived shall be applied solely toward the promotion and furtherance of the objects of the Association and no part thereof shall be paid or transferred directly or indirectly by way of bonus or otherwise as profit or gain to members past present or future of the Association or any person claiming through any member; provided however that nothing herein contained shall prevent the *bona fide* payment of remuneration to any secretary treasurer registrar editor officer clerk servant or other person or persons for services actually rendered to the Association whether such are members of the Association or not and the expenses of directors or other officers incurred in performing the business of the Association.

BOOKS.

25. The secretary shall keep at the head office of the Association a book wherein shall be printed a copy of the constitution and regulations of the Association and a list of the members. A copy of such book shall be supplied to every member of the Association upon his first joining the Association free of charge and subsequently on application and on payment of a fee of one shilling.

REGISTRATION AND MEMBERSHIP FEES.

26. All fees shall be paid in cash to the Secretary and shall forthwith be deposited by him to the credit of the Association in a Bank arranged with by the Board.

CORPORATE SEAL.

27. The Association shall have and use, as occasion may require, a Seal or Stamp as may be decided upon by the Board.

REGISTRATION OF PEDIGREES.

28. A register shall be kept at the office of the Association. This register shall be known as "The Fiji Stud Book" and shall contain a copy of the constitution and may be consulted by any member at any time.

29. There shall be delivered to every person recording an animal a certificate of registration in such form as may be decided by the Board.

30. Herd books shall be published at such time and in such form as may be decided by the Board.

31. Any person expelled from membership shall not be allowed the privilege of recording pedigrees on the register of the Association.

32. Any member in arrears of membership fees shall not be allowed the privilege of recording pedigrees on the books of the Association.

33. The Board shall have power for any cause which in the opinion of the Board seems proper to suspend any member or refuse applications for registration or transfer from any person whether a member or not pending action by the Board or a general meeting of the Association.

ENTRY REGULATIONS.

34. In order to qualify for registration in the Fiji Stud Book animals must be the direct progeny of registered animals on both sire's and dam's side.

35. In the case of imported animals application for registration must be accompanied by official pedigree export and transfer certificates and be entered in the Stud Book of their respective breed in the country of origin. The provision of this Regulation shall not apply to animals imported prior to the first day of January, 1930, provided that application for registration of such animals must be accompanied by evidence to the satisfaction of the Board of the pure breeding of such animals.

36. In the case of animals bred in Fiji application for registration must be accompanied by a sworn declaration from the breeder as to its breeding. Such registration shall not be complete until the animal has been inspected and approved by a Government Veterinary Officer.

36A. Application for registrations of animals of the Friesian breed of cattle must be accompanied by certified photographs of such animals.

37. Animals the progeny of sire and dam already registered in the Fiji Stud Book will be accepted for registration on the sworn declaration of the breeder after the animal has been inspected and approved by a Government Veterinary Officer.

38. Application for registration of an animal sired outside Fiji but born in Fiji the progeny of an imported stud animal must be accompanied by a certificate of service signed by the owner of the sire. The provisions of this Regulation shall not apply to any animal sired outside Fiji but born in Fiji the progeny of a stud animal imported prior to the first day of January, 1930, provided that application for registration of such animal must be accompanied by evidence to the satisfaction of the Board of the pure breeding of such animal.

39. In the application for registration of any animal the Herd Book number of sire and dam must be given.

40. All applications for registration &c., of horses and cattle must be made on the correct forms issued for the purpose. Any form not correctly filled in will be returned to the applicant for completion. No application will be considered unless accompanied by the fee prescribed.

41. Official forms will be as follows—

- (a) application for registration form;
- (b) transfer certificate, original and duplicate;
- (c) extended pedigree certificate;
- (d) certificate of service;
- (e) form of monthly notification of births in herd;
- (f) form of notification of deaths in herd;
- (g) export certificate.

42. All animals born in Fiji must be branded by the breeder before registration or sale and in addition must bear either a fire brand on the skin or a tattoo mark in the left ear indicating the herd number of the animal. This should be done in the following manner. Irrespective of age or sex beginning with 1. Each animal will be numbered consecutively in the order of its birth. The registered brand and herd number must be shown on the form when the application for registration is made and on any transfer certificate.

43. The breeder of any animal must register the animal before any transfer by him can be recorded.

44. The vendor is responsible for the compulsory registration of transfer and payment of transfer fees. Application for registration of a transfer not received within three months of such transfer shall be specially considered and if deemed necessary a fine for delay may be imposed. The official form must be used in all cases of transfer.

45. The Fiji Stud Book will be published yearly and all applications for entry must be lodged not later than the thirtieth day of June in each year.

46. If an inaccuracy or omission be discovered relating to any entry or if an entry shall prove to have been wrongly or incorrectly made such entry shall be cancelled by the Board and the Fiji Stud Book amended accordingly.

47. All animals born in Fiji when registered shall be branded with the Association's mark.

FEES.

48. The following fees shall be charged—

Life membership	£5 5 0
Annual membership	0 10 0
Registration of transfer	0 2 6
Registration of prefix or suffix to name	0 5 0
For book of Regulations and list of members	0 1 0

Registration of Animals—

Members of the Association—

For the first male	0 5 0
For the first female	0 3 0
All subsequent registrations, each	0 1 0

Non-members of the Association—

Male animals, each	0 5 0
Female animals, each	0 3 0

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Vol. 3.]

1930.

[No. 1.



AGRICULTURAL JOURNAL

*Issued by the
Department of Agriculture, Fiji.*

PRICE, ONE SHILLING.

27518/136

BY AUTHORITY: J. J. McHUGH, GOVERNMENT PRINTER, SUVA.

1930.

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 3.]

FIRST QUARTER, 1930.

[No. 1.

EDITORIAL.

A SUCCESSFUL Agricultural Conference, presided over by His Excellency the Governor, was held in the Supreme Court House, Suva, on January 17th and 18th, 1930. The Conference was originally planned as a purely Departmental function for the Staff, but, at the express wish of His Excellency the Governor, its sphere was extended and the proceedings were made public. There was a representative gathering at the opening of the proceedings and keen interest was taken by all who attended, as is evidenced by the discussions on the papers read, which are published in this number of the *Journal*. The occasion of the Conference afforded members of the Department, many of whom are situated in distant parts of the Group, an opportunity to meet and discuss various matters of interest not recorded in the proceedings. The Superintendent of Agriculture and Mrs. Barnes were "At Home" to members of the staff and their wives on the afternoon of January 17th, when an enjoyable time was spent. It has been decided to make the Conference an annual function of a public nature and to invite contributions from members of the agricultural and commercial community, as well as from members of the Department. It is probable that the occasion of the Fiji Agricultural Show will be a convenient time at which to hold the Annual Conference. Open discussion of agricultural problems cannot but be beneficial, and a closer co-operation between the Agricultural Department and the community can best be effected by the holding of periodical conventions of this nature.

THE DECEMBER STORM.

It is unfortunate to have to record that a serious cyclonic storm visited the Group early in December and caused considerable damage to standing crops and property in certain districts. In Vitilevu the storm was accompanied by exceptionally heavy rainfall, which caused a serious flood of the Rewa river and resulted in considerable damage. The adverse effects of the storm were reflected in the banana shipments for the months of December and January. It will be a few months before the quantity of fruit available for export becomes normal. It is comforting to note, however, that serious as the damage was in many areas, investigation proved it not to be so great as was originally estimated. The field staff of the Agricultural Department has made surveys of the storm damage in various districts and a number of officers took prompt measures in regard to relief work. Mr. Anson, Cotton Specialist, and Mr. Field, Cotton Inspector, are particularly deserving of praise in this connection. They have been officially thanked for their services on storm relief work by His Excellency the Governor.

LIVE STOCK RECORD ASSOCIATION.

The quarterly meeting of the Board of Directors of this Association and the annual general meeting were held on December 17th. The Minutes

of the meetings will be found in this number of the *Journal*. All interested in the stock industry are urged to become members of this Association which has for its object the improvement of cattle, horses and other stock in Fiji.

TAILEVU DAIRY SCHEME.

His Excellency the Governor, attended by Sub-Inspector W. J. G. Holland, A.D.C., and accompanied by the Superintendent of Agriculture and the Secretary of the Tailevu Dairy Scheme, visited the Tailevu district on Thursday January 30th, returning to Suva on 1st February. The party landed at Lodon and after a ceremonial welcome by the native community, walked along the track of the proposed Lodon-Korovou road to the end of the completed portion of the road near Burerua. They proceeded by car to Korovou and afterwards drove over the northern section of the Korovou-Naduruloulou road. The following day His Excellency inspected the school and the dairy factory, afterwards presiding over the annual general meeting of the suppliers of butter-fat to the Tailevu Dairy Factory. After an informal lunch kindly provided by the settlers and their wives His Excellency and party inspected each homestead on the Government Tailevu Dairy Scheme. In the evening His Excellency was "At Home" to settlers, their wives and families at the house of Mr. W. T. Gatward. The keen interest taken by His Excellency the Governor in all affairs connected with the Settlement cannot but be attended by excellent results. There can be no doubt that whatever the past history of the Settlement may be, it is now firmly established and can look forward to a prosperous future. The matter of communications evidenced by the construction of the main road from Naduruloulou and the excellent system of local roads now being pushed in the direction of Lodon by the Tailevu Road Board will remove the feeling of isolation hitherto experienced by the residents and inspire them to increased exertion. They were assured at the last meeting of Legislative Council of a sympathetic consideration by Government and that assurance has been exemplified by His Excellency's visit.

STAFF NOTES.

Mr. C. R. Turbet, B.V.Sc., returned from leave and assumed duty as Chief Veterinary Officer on the 11th January, 1930.

Mr. H. M. Stuchbery, B.V.Sc., proceeded on three months' leave on 18th January, 1930.

Mr. T. H. C. Taylor, B.Sc., sailed for Java on coconut investigation work by the "Niagara" on 29th November, 1929. He is due to return by the repatriation vessel "Sutlej" scheduled to arrive in Suva on February, 28th, 1930.

Mr. G. A. Wishart, Assistant Inspector of Produce, resigned his appointment with effect from the 20th November, 1929.

Mr. L. B. Greaves, Temporary Inspector of Plantations, has been gazetted Acting Assistant Inspector of Produce, temporary, with effect from the 20th November, 1929.

Mr. B. F. Hooper has been appointed Assistant Agricultural Officer, temporary, and has assumed charge of the Nasinu and Navuso Experimental Stations. Mr. Hooper took up duty on the 1st January, 1930.

Mr. T. R. Colebrook was gazetted Stock Inspector for work in the Northern and Western districts of Vitilevu on the 21st October, 1929.

Mr. J. C. Flemons joined the Department as an Agricultural Pupil on the 10th February, 1930.

AGRICULTURAL CONFERENCE.

THE following are the proceedings of an Agricultural Conference held at the Supreme Court House, Suva, under the presidency of His Excellency the Governor, Sir A. W. Murchison Fletcher, Kt., C.M.G., C.B.E., on January 17th and 18th, 1930:—

His Excellency the Governor.—*Mr. Barnes, ladies and gentlemen, it gives me great pleasure to open this Conference this morning and I am particularly pleased to see such a good muster in view of the short notice that the Conference would be open to the public. I attach the greatest importance to a meeting of this kind. We have to live in this Colony by agriculture and it is necessary that we should study by all means in our power the methods by which we can improve the agriculture which we carry on. Here we have the need of expert advice, and we want co-ordination, we want the assistance and co-operation of the community which is actually engaged in planting. What we require is not so much theory as practical agriculture. The Colonial Sugar Refining Company has set us an excellent example in its system for the small tenant farmer. They teach their men how to cultivate, how to rotate crops, and especially they see that they do it. That is all important. That is what is meant by practical assistance of agriculture, and to get practical results requires adult education. Education is very much to the front at the present time in Fiji but I think we should go further than just teaching the "three R's." We should teach the people to live on the soil. It is an excellent thing to teach the young children to read and write, but it is no good to teach only the small boy how to grow potatoes because if he went home and tried to instruct his father he would most likely be cuffed, but if you teach the adult labourer and the small tenant farmer about agriculture his son will learn from him. We have quite a number of interesting papers before us and I will call upon Mr. Barnes to read his paper on "Fruit Production for Export." When the papers have been read I would ask that any persons who are interested in the various papers to take part in the discussions and ask any questions that may occur to them.*

Mr. Barnes.—Before proceeding to read the paper which stands in my name I wish to thank Your Excellency for the very keen interest you have taken in this Conference and its objects, and your kindness in consenting not only to open the Conference this morning but to give your most valuable time to be present throughout all its sessions. On behalf of my staff I wish to say that we deeply appreciate this kind thoughtfulness on your part.

FRUIT PRODUCTION FOR EXPORT—PART I.—CITRUS FRUITS.

By A. C. BARNES, F.I.C., B.Sc., A.M.I.Ch.E., Superintendent of Agriculture.

YOUR Excellency, ladies and gentlemen,—I wish to state that my object in preparing this paper for this Conference was to endeavour in the first place to stimulate interest in the growing of citrus fruits for export, and to provide an outline of information for the few people who are keenly interested and who in one or two cases have already taken steps to establish small plantations. I can assure anyone interested in this particular subject that the staff of the Department will be happy to render whatever assistance they can in any way, both in the more theoretical form of lending literature and the practical manner of giving what instruction is possible actually on the ground.

INTRODUCTION.

The cultivation and export of citrus fruits is a subject which has engaged the attention of many of the Colonies and Dominions for some years past. The Union of South Africa, for example, is now one of the largest suppliers to Great Britain and the industry there is very well organised. Fiji by reason of its situation in the tropical belt, its climate and its soil is eminently suited to the production of all grades of oranges, grape fruit, lemons and limes suitable for overseas markets. Although it is unlikely that such an industry will ever assume the same importance as sugar or copra in the Colony, it is nevertheless worthy of a place amongst the more important agricultural industries here. Fiji has before it the lessons learned under great difficulty and expense in other Colonies and should be able to embark on this industry without experiencing so many of the set backs that have jeopardised its success in other places in the past. With any product intended for sale it is essential to establish a standard quality which can be maintained. Any marked irregularity in the quality of fruit offered for sale in overseas markets will seriously affect the esteem with which the public regards that fruit and unless a marketable standard is maintained the whole year round the product is not likely to command a ready sale. Popular varieties of fruit must be grown under carefully controlled conditions; they must be properly harvested at the right stage of development, carefully handled, cured, wrapped and packed in attractive containers for export. Neglect of the most careful attention in every stage of the development of the tree, the harvesting, treatment and export of the fruit will influence the price and the degree with which the product can maintain its place in the market. In this paper a brief outline of the whole process of the production of fruit for export from the establishment of the nursery to the shipment of the fruit will be given.

Plant Propagation.—Though excellent fruit is produced from seedling trees, fruit from different trees is never of uniform quality. The fruit varies in size, texture, flavour, number of seeds and in other characteristics and it is not possible to supply market requirements from the fruit of such trees. It is therefore necessary to resort to some method of propagation whereby a fruit of standard characteristics can be obtained from many hundreds or thousands of trees. This involves some form of vegetative propagation. In the case of citrus, budding is normally practiced. Root stocks are raised from sturdy varieties, generally rough lemon or sour oranges, and are budded at a height of nine inches from the ground when the young plant is about the thickness of a pencil. The best season for budding in Fiji will probably be found to be September–November. Seeds may either be planted in rows and transplanted 18 in. by 18 in. when they are big enough, or they may be planted 18 in. by 18 in. in the first place and budded without transplantation when they are sufficiently well grown. The latter method saves labour and so long as weedy and weak plants are not budded, may be regarded as quite satisfactory. It is, however, essential to utilize only sturdy stocks of a good habit of growth. The young root stocks should be trained to a single stem and branching growth checked in the early stages. This results in much sturdier growth and is likely to influence beneficially the budding operation later to be undertaken. The technique of budding is simple and can be readily picked up after a few trials. Bud wood should be very carefully selected from mature trees of the varieties it is desired to propagate which have borne fruit for several seasons. Bud wood should only be taken from trees of sturdy growth which are known to yield good crops. The wood from which the buds are taken should be one year old.

The buds after insertion in the stem of the root stock should be carefully protected from rain and sun. A binding of tape soaked in a composition of resin, beeswax and tallow should be used and an inverted leaf tied over the bud to protect it from the sun. When the bud has properly united with the stock the upper part of the plant should be cut half through on the budded side and bent over in the opposite direction to force the bud. As soon as the bud has formed a sturdy shoot the stem of the root stock should be cut through a few inches above the bud and as the shoot from the bud or "scion" further develops, the root stock should be cut back carefully with a slanting cut just above the union and the cut surface treated with tar or paint to prevent any access of water. The budded plant will be ready for removal to its permanent home after about two years, but considerable care is necessary during the whole of this period. The "scion" should be trained in the early stages to a single strong stem which should not be allowed to branch too much subsequently. Watering must be practiced whenever the rainfall is insufficient to keep the ground moist. This applies throughout the whole proceedings from the time of the early sowing of the seed until the plant is properly established in its permanent home. Propagation by layering from good trees is another method recommended by some authorities. The technique of this process is described in standard works on fruit culture.

Planting.—The land selected should be well drained, with a free working soil which should be thoroughly cleared of all growth and well cultivated to a depth of 6 in. to 8 in. Planting distances for citrus varieties vary from 15 ft. by 15 ft. to 24 ft. by 24 ft., usually 18 ft. by 18 ft. or 20 ft. by 20 ft. will be found satisfactory. The ground should be carefully lined up and holed some time before the planting operation is to be undertaken. The holes should be 2 feet in diameter by 2 feet deep. When the budded plants are removed from the nursery they should be carefully pruned back to leave only a few strong shoots at the top. The stem for a distance of 18 in. to 2 feet should be quite free from any branching growth. The roots should also be pruned. In planting it will be found that a planting stick is of great assistance. This should be notched in such a manner that two notches correspond with the outer edges of the hole and a notch midway between with the centre. By placing the planting stick across in such a manner that the centre notch is exactly over the middle of the hole it is easy to hold the plant in such a position that it will be planted to the same depth as in the nursery. Surface soil only should be used for filling up the holes and should be carefully worked round the roots by hand, then trodden down in layers in such a manner so as not to cramp the roots or to damage them. It is essential that the plant should not be put in to a greater depth than it was when in the nursery. Shallow planting is much less dangerous than deep planting and allowance should be made for subsidence of the soil in the hole. Collar rot, a serious source of loss of trees, is largely avoided in this way. Care should be taken as planting proceeds to check the lining in all directions, as nothing looks worse than a badly laid out plantation. A good surface mulch should be maintained around the plant and the space between the plants kept under cover either by planting a suitable catch crop or by growing a nitrogenous cover crop. Given satisfactory conditions the plants will soon become established and will give signs of vigorous growth. All shoots which appear on the main stem should be rubbed off with the thumb and finger and should never be allowed to reach the stage where it is necessary actually to cut them with a knife.

Care of Trees.—The plants should be carefully watched to ensure that they develop into well shaped trees and should as a rule be allowed to fork

in only two directions. Subsequent forking of the main branches should, if necessary, be carefully controlled. The object is to get a well shaped tree to all parts of which light and air can obtain free access. In this way the incidence of any disease will be minimised and the tree assisted to bear the maximum quantity of fruit. The trees may be expected to bear fruit in about three years, but for the first one or two seasons the flavour of fruit may be influenced by the nature of the original root stock which will be superimposed upon that of the fruit of the trees from which the buds were taken. This somewhat objectionable characteristic disappears after one or two seasons when the tree settles down to produce a uniform quality of fruit.

Harvesting.—Harvesting of citrus fruit when carried out in a proper manner is not so simple an operation as it would appear. It is essential that fruit be harvested dry and free from dew or mist deposited on the surface. Fruit should always be cut from the trees by special clippers leaving a short length of stalk attached to the fruit. The stem is then again cut as close as possible to the fruit. The harvesters should wear gloves in order to prevent damage to the skin, which is one of the greatest sources of the rotting of fruit by infection of the scratches caused by careless handling as it is cut. The fruit should be loosely packed in boxes fitted with handles for ease of carrying and when boxes are filled they should be transported to the packing station in such a manner as to prevent any bruising of the fruit.

PACKING STATION OPERATIONS.

(a) *Curing.*—The subsequent treatment of the fruit depends largely on the requirements of the market and the time necessarily elapsing between the packing and the consumption. In the case of Fijian fruit it would probably be satisfactory to omit one or two of the operations practiced in those countries which supply fruit to more distant markets than those which are available to Fiji. On arrival at the packing station the fruit should be placed in a dry, cool, well ventilated situation for about two days. During this period surplus moisture passes off from the skin, which becomes somewhat toughened and rendered less susceptible to injury in the subsequent operations.

(b) *Sorting.*—This consists in the culling of diseased, damaged and otherwise unsuitable fruit for export. Any such fruits overlooked during the initial sorting are removed during the sizing and packing stages.

(c) *Artificial Colouring.*—This is often practiced when the fruit as ready for packing is green or irregularly coloured. The object is to obtain a uniform colour of the skin, a condition which greatly adds to the attractive appearance of the fruit. The ripening of the fruit and development of sugar in the juice are speeded up by the process which is now carried out by treatment with ethylene gas in a special manner.

(d) *Washing &c.*—In some instances the fruit is washed, brushed and dried by mechanical means, a solution containing chemicals which prevent the subsequent growth of mould being sometimes used. Grapefruit is afterwards coated with a very thin layer of wax to enhance its appearance.

(e) *Sizing.*—The sorting of the fruit into sizes is done mechanically and the types of machinery used vary with the output of the station. The object is to secure fruits of uniform sizes for packing. This operation cannot be carried out by the hand and eye without mechanical aid, which may however be of quite simple design. With properly sorted fruit, packing is greatly simplified and the standard size of boxes used hold definite numbers.

of fruit varying from box to box in accordance with the diameter of the fruit. The standard "packs" for South African fruits are given in 21 (g) of the extracts from Fruit Export Regulations.

(f) *Wrapping and Packing*.—Each fruit is wrapped in thin, tough white tissue paper, cut to sizes suited to the different "packs." The printing of an attractive design on one side of the paper adds to the pleasing appearance of the packed fruit. When wrapped, the design should be on the outside. The whole fruit is covered by paper which is fastened by a firm twist at each end. The operations of wrapping and packing are usually carried on together as the fruit leaves the sizing machine. The method of placing the fruit in the boxes depends on the size, and special printed instructions are used by packers. Loose packing is at all costs to be avoided as the fruit is bruised and spoiled in transit to the market. Standard packs more than fill the boxes, and pressure is necessary to force the fruit down before nailing on the lid. Presses are often used for this purpose. Boxes are of uniform size and constructed to a standard specification.

Inspection and Export Control.—Fruit-exporting counties have realised the necessity for systems of strict inspection and control. In the earlier stages these often appear to bear harshly on exporters, but in the long run their advantages are so obvious as to need no recommendation. They are entirely in the best interests of producers, exporters and consumers.

The following extracts from the latest regulations under the Fruit Export Act 1914 of the Union of South Africa illustrate some of the matters requiring legal enforcement if a fruit export industry is to succeed in holding a satisfactory position in the World's markets:—

REGULATIONS.

1. No fruit intended for export shall be inspected under these regulations unless the requirements of the Perishable Products Export Control Board in respect of the registration of the name, address, distinctive brand and number of the person intending to export citrus fruit, and of the rendering of estimates of intended shipments shall have been complied with.—*Vide Regulations Nos. 25 and 26 of the Perishable Products Export Control Board, which are contained in the Appendix hereto.*

2. For each consignment of fruit examined by the inspector the exporter shall pay at the rate of one shilling and four pence per 40 cubic feet of packages of fruit.

(Attention is also directed to Government Notice No. 1,452 of the 4th September, 1922, prescribing a special fee of 5s. per 40 cubic feet to be paid in respect of the inspection and grading of citrus fruit exported).

5. Every box of fruit submitted for inspection must be consigned to the person or agent appointed by the exporter to arrange the shipment thereof from the various ports, and every consignment shall be accompanied by two Fruit Consignment Declaration Export Notes, in which all the specifications required are given.

6. Boards of reference, composed of persons whose names have been approved for that purpose by the Minister, have been constituted at the ports of Capetown, Port Elizabeth, East London and Durban, and will be established at such other places as may be necessary, to which an exporter may appeal if the inspector refuses to brand or stamp any box of fruit belonging to such exporter.

7. A fee on the basis of 10s. per one ton or portion thereof, and for any quantity over one ton 5s. per ton extra, with a maximum of £5 10s. shall be deposited with the inspector by the consignor of each consignment of fruit upon which the consignor may require the inspector to obtain the decision of the Board of Reference under the provisions of Sections 5 of the Act.

8. The consignor shall, within twenty-four hours of the time of receiving the inspectors' notice remove from the place of inspection any fruit which the inspector has refused to brand or stamp, or which, having been referred to the Board of Reference, has been decided upon by the Board in favour of the inspector. Whenever it shall appear that there is a danger of rejected fruit contaminating other perishables the Fruit Inspector may require the consignor or his agent to remove such fruit forthwith.

(*Note*.—Attention is invited to Section 6 of Act No. 17, 1914, empowering the Inspector of Fruit to destroy or otherwise dispose of fruit rejected by him for export which is not removed from the place of inspection within the period prescribed by the regulation and providing that any expense of storing pending removal shall be a charge against the owner of such fruit).

9. Boxes of fruit marked so as to represent a grade higher than the correct grade shall be re-marked by the Inspector, and, if otherwise complying with these regulations, branded or stamped by the Inspector as provided in section 4 of the Act.

11. Not less than 5 per cent. of the boxes of fruit in each consignment shall be opened by the Inspector for examination, and all boxes so opened shall be stamped by the Inspector to that effect.

12. Only new and clean boxes or packages shall be used by exporters.

13. Provides for the special marking of boxes.

16. Citrus fruit shall be packed in boxes, the size of which shall be:—

ORANGES AND GRAPEFRUIT.

Outside measurement.—26 in. by 12 in. by 12 in. (with centre piece).

Wood required.—Ends and middle piece (three pieces), $11\frac{1}{2}$ in. by $11\frac{1}{2}$ in. by $11\frac{1}{16}$ in. Top, bottom and sides (eight pieces) 26 in. by $5\frac{1}{2}$ in. by $\frac{1}{4}$ in. Cleats (two pieces) either 11 in. by $\frac{3}{8}$ in. by $\frac{3}{8}$ in. or 11 in. by 1 in. by $\frac{1}{2}$ in.

(The ends of orange boxes and grape fruit boxes are to be firmly fastened together with metal fasteners. No ends or centre pieces are to be made of two pieces of equal width. Cleats for grape-fruit boxes must be coloured red).

(b) *Naartjes.*—Outside measurement, 26 in. by 12 in. by not more than 6 in. deep with centre piece. For the export seasons 1928 and 1929 boxes 18 in. by 12 in. by not more than $4\frac{1}{2}$ in. deep will be permitted but not thereafter.

(c) *Lemons.*—Lemons may be packed in any of the standard citrus packages.

(d) All boxes shall have cleats on the lids. The 12 in. deep boxes shall be strapped at each end and in the middle, but the shallower boxes need not be strapped. The strapping shall be nailed over the cleats, but the middle of the lid shall not be nailed to the centre piece. Wire-bound boxes shall not be allowed.

18. Each citrus fruit shall be wrapped in tissue or other similar paper. If wrappers are descriptive of any particular variety of citrus, such description must agree with the fruit contained therein.

21. The following shall be the grades for the fruits mentioned:—

A—ORANGES.

(a) “Fancy” fruit shall be that which is free from all blemish and injury.

(e) *Maturity.*—No oranges shall be exported unless—

(i) they have attained 70 per cent. yellow or orange colour;

(ii) they show on test not less than the following ratio of total soluble solids to acids:—

Seedlings	..	..	..	5.0	1
Valencia and other late varieties	..	..	..	5.5	1
Navels	..	..	..	6.0	1

(f) *Minimum weight.*—The minimum weight of boxes of sizes 80 to 126 shall be not less than 74 lb and all longer counts must weigh not less than 77 lb per packed box; the net weight of the fruit shall be not less than 64 lb and 67 lb respectively.

(g) *Size.*—The size shall not determine the grade. The sizes of fruit shall be as follows:—

Counts of	80	per box,	average diameter	$3\frac{1}{4}$ in.
..	96	..	..	$3\frac{3}{8}$ in.
..	112	..	..	$3\frac{1}{2}$ in.
..	126	..	..	$3\frac{5}{8}$ in.
..	150	..	..	3 in.
..	176	..	..	$2\frac{7}{8}$ in.
..	200	..	..	$2\frac{3}{4}$ in.
..	216	..	..	$2\frac{5}{8}$ in.
..	226	..	..	$2\frac{9}{16}$ in.
..	252	..	..	$2\frac{1}{2}$ in.
..	288	..	..	$2\frac{3}{8}$ in.
..	324	..	..	$2\frac{1}{4}$ in.
..	344	..	..	$2\frac{1}{8}$ in.
..	360	..	..	2 in.

Literature.—A wealth of literature on the varied aspects of citrus growing is available in the form of standard works by authoritative writers and pamphlets issued by Universities and Departments of Agriculture in many countries. A list of such books and papers is kept at the office of the Agricultural Department in Suva. Assistance to those desiring more information than the cursory outline given in this paper will gladly be rendered.

DISCUSSION.

His Excellency the Governor.—I am sure we have all listened with great interest to Mr. Barnes. I recommend to the notice of the Planters' Association what he says about the matters of standard quality and inspection and control. These things are governed by Gresham's Law—a bad coinage drives out a good. In the same way if you allow bad fruit to get on to the market from Fiji your good stuff is tarred with the same brush and you get inferior prices. I can quote an example of the importance of control and inspection in Hong Kong. There the Government guarantees by certificate the quality of tin. The tin is brought into Hong Kong from away back in the hills, sometimes 100 miles distant and a certificate for 99 per cent. fine is given. That certificate is accepted without question all over the world. In the same way you have the Sun Kist Oranges, which are fruit of the first quality. The people of California refuse to ship any fruit that is not of first class quality.

Mr. Faddy.—Where would be the principal markets for citrus fruits grown in Fiji?

Mr. Barnes.—In my opinion the principal markets for Fijian citrus fruit would be New Zealand and Australia. I am aware that New Zealand grows part of its own requirements. As I mentioned in the early part of the paper I do not assume for a moment that citrus production in Fiji will reach large proportions, but I think it is well worthy of consideration.

Mr. Faddy.—At one time we were in the fruit industry in Sydney and we noticed that oranges and mandarines from the islands were very difficult to sell on account of the fact that they were green in colour, and it appears to me that if the citrus industry in Fiji is to be a success it would be necessary to overcome this difficulty by colouring the fruit in some way. The same objection exists in New Zealand.

Mr. Barnes.—Mr. Faddy has raised a very important question. It is a point with which I dealt in the paper when I mentioned the fact that some markets demand a normally coloured fruit. Colouring can be done by comparatively simple artificial means. I would despair of ever succeeding in the education of the British public, whether at Home or in the Colonies to eat green fruit. There is a rooted objection which has been passed down for generations to the eating of green fruit. The cheaper method would be to colour the fruit and send it to them as they like it rather than try to make them buy it as we think they ought to buy it.

Mr. Macdonald.—We have the fruit fly in Fiji which necessitates the early picking of citrus fruit intended for export.

Mr. Barnes.—It should be possible to overcome this difficulty. The matter requires study by the scientific staff.

Mr. Surridge.—The following points occur to me as arising out of your paper on Citrus Fruit:—

1. *Time of budding.*—You state September to November. Would not this be too early for most parts of these islands? I should think November and December.
2. *Budding tape.*—You suggest a resinous tape for the necessary budding. Would not clay or a mixture of cow dung and clay, both substances usually to hand on a plantation, answer the same purpose?
3. *Distance of planting.*—You give a minimum of 15 feet each way. Some parts of Australia plant 12 feet apart. Which do you advise? Also, would you favour the quincunx system of planting, i.e., the equilateral triangle, as against the square system? Either allows for cultivation between the trees, but the quincunx is more economical of space.

4. *Depth of planting.*—In planting young stock, is it not advisable to use the "nursery mark" as control on depth of planting?
5. *Grading of Fruit.*—In dealing with the question of grading, the wholesaler and general public only have been mentioned, but the major loss of bad packing falls on the retailer who, in purchasing, has to stand the loss of bad fruit while maintaining his prices at competitive rates.

Mr. Barness.—The points raised by Mr. Surridge are most interesting and many of them are vital, I think, to the subject under discussion. In regard to the question of the time of budding, I cannot say that I have yet had any experience of any type of citrus fruits in Fiji, but I have discussed the matter with people who have done a certain amount of work here. Mr. Hayes of Sigatoka has budded during the time stated in my paper with excellent results. In connection with the type of budding tape I mentioned, that, I may say, is one of many which is used for the purpose. Reference can be made to any of the standard books on the subject of citrus growing. I would strongly recommend that some such material as that mentioned in my paper should be used in preference to clay or cow dung. The object of the budding tape is to bind the stem firmly and at the same time to prevent the access of moisture to the wound or inserted bud. With regard to the distance of planting, this is a matter which is the cause of some contention amongst planters. I prefer the quincunx system as it allows of planting more trees at the same distance apart in a given area. The distances 9 ft by 9ft. and 12 ft. by 12 ft. mentioned by Mr. Surridge are far too close. Trees for the first years' growth have ample room for all their requirements, but after four or five years they become so overcrowded that there is the tendency for them to grow high in order to catch the sunlight with the result that the trees have comparatively thin branches which cannot bear the load of fruit that a properly grown tree will, and difficulty in the harvesting of the fruit is caused. In regard to the depth of planting, citrus is subject to collar rot, and though the "nursery mark" is a guide to planting depth, it is preferable to have this slightly above ground level rather than below it.

Mr. Caughley.—I would like to ask Mr. Barnes about the extraction of the juice of the limes.

Mr. Barnes.—This is a point which was considered by a predecessor in my office many years ago who imported a cider press for the purpose of expressing the juice. That press is still at Nasinu. The expression of the juice of the lime and lemon has attained great importance in Sicily and the West Indies. For Fiji to embark upon this industry would involve the establishment of large plantations of different varieties of the fruit mentioned and the industry would demand a high degree of organisation followed by some method of penetrating the market. I think it would be more profitable to go for the fresh fruit markets at first.

Mr. Blackie.—Apparently a great deal of labour would be entailed in the proper control of citrus trees, necessitating expert supervision. Would the products be a marketable success from this point of view?

Mr. Barnes.—This question also is of importance. As I mentioned, I have prepared this paper with the object of interesting people. The degree of organisation should not be very great in the early stages. Everything would depend on the quality of the fruit which was grown and sold in the export markets. There is no reason why the quantity offered for export should not be increased and the quality improved.

Mr. Faddy.—Raised the point about a regulation being in force that prevented anyone sending citrus fruit to Australia in excess of the quantity shipped the previous year and that one year a gentleman could only ship one case of oranges because that was the quantity shipped the previous year.

Mr. Duncan.—The whole question boils down to one of markets. There is no Australian market for Fiji citrus fruits.

Mr. Barnes.—I think there is one important point that has been overlooked and that is the question of the local market. That is a point which is well worthy of attention in the near future. In South Africa, one of the homes of the citrus industry, the industry is highly organised. Growers and producers have formed co-operative societies in the various districts and there is practically no individual marketing of fruit. It should be possible to work on similar lines in Fiji to ensure that local demands are supplied.

Mr. Barker.—Raised the question about the prohibition of the importation of limes into New Zealand.

Mr. Barnes.—I am not aware that there is any prohibition of the importation of limes into New Zealand. I will look into this matter. All these questions require to be explored before embarking upon an industry of this description.

His Excellency the Governor.—I now ask *Mr. Anson* to read his paper on the Cotton Industry.

RESUME OF WORK AT THE COTTON EXPERIMENTAL STATION.

By R. R. ANSON, Cotton Specialist.

ON the recommendation of Mr. G. Evans, who made a thorough tour of the Fiji Islands during July and August of 1924, I was appointed by the Empire Cotton Growing Corporation and attached to the Government of Fiji as Cotton Specialist. The primary object of my appointment being that of plant breeding on cotton, with a view to raising new and improved types, together with testing new varieties and carrying out experiments on the cultivation. Several varieties have been tried out at the Experimental Station, including:—

Kidney Gossypium Braziliense which was obtained from seed found growing locally and is a perennial shrub or small tree with united or conglomerate seeds and possesses coarse lint used mainly for mixing with wool. The staple measures from 1 in. to $1\frac{1}{2}$ in.

Meade Gossypium Hirsutum.—A variety which originated from a single plant selection made in 1912 by Rowland Meade from a field of Black Rattler. It was introduced into the Sea Island areas of Georgia and South Carolina because Sea Island could not be grown profitably in the regions infested with boll weevils.

Tanguis Gossypium Peruvianum.—Produced originally about the year 1908 by Senor Cermin Tanguis. It is said to be a Hybrid of Egyptian and Semi Rough Peruvian. It is usually grown under irrigation and the staple averages 1-3/16 in. to $1\frac{1}{4}$ in.

Acala Gossypium Hirsutum.—An American upland variety evolved by G. N. Collins and C. B. Doyle from imported seed from Southern Mexico. The present strain was developed from twenty selected plants by Dr. D. A. Saunders, and our seed was obtained from Australia.

Pima Gossypium Peruvianum.—An American-Egyptian variety grown, mainly in Arizona and California and used for manufacturing of tire yarns balloon cloth and aeroplane fabrics.

Sakellarides *Gossypium Peruvianum*.—An Egyptian cotton which was brought out about the year 1907 from a single plant selection from Jannovitch.

Several of these cottons have been crossed with Sea Island.

The only ones which have shown any promise of becoming commercially successful are:—Sea Island, Kidney and a Hybrid Sea Island Kidney cross, which originated from five of the most promising of twenty-eight single plant selections made by Mr. Evans from Kidney Hybrid cottons found growing at Kayapet, Markham Valley, New Guinea. Of the original twenty-eight selections sent out by Mr. Evans eleven possess conglomerate seeds which did not cling together as in ordinary Kidney cottons. Five of these which appeared to be the best were sent out to Fiji by the Empire Cotton Growing Corporation for trial.

During the past few years the uncertainty of the market for Sea Island cotton made it necessary to try out experiments in order to ascertain whether it will be possible to substitute it by some other variety which would be more saleable, and at the same time, give the grower as good a return per acre.

It is well known that owing to its length, strength and fineness of staple, Sea Island has always commanded a higher price than other cottons, but the size and character of the bolls make picking difficult, and a picker can rarely maintain an average of more than thirty pounds of seed cotton in a ten-hour day. A cotton that will compare favourably with it, from a grower's point of view, must therefore be a type which possesses a larger boll, a higher percentage of lint, a higher percentage of first-grade cotton per acre, a better yielder, and at the same time produces a lint of such quality that the price will be as close as possible to that of Sea Island.

The average percentage of Sea Island A and B grades taken during the first four seasons has been high—69.41 per cent.—and it will not be an easy matter to find a cotton which will beat this. The grade and class are governed to a great extent by weather conditions at the time of maturity, the dryer the weather at picking time the higher the percentage of good quality cotton. According to the rainfall statistics taken over a period of twenty years in the dry zones of Vitilevu and Vanualevu Islands the driest weather was experienced during the months of June, July, August, September and October. The Sea Island crop when planted in mid November usually reaches maturity in April and picking is continued until the end of August. The Kidney Hybrid planted at the same time does not reach maturity until June and picking is continued until the end of December. This fits in with the driest months and it is hoped that it will be possible to obtain a higher percentage of first grade cotton than is the case with Sea Island. As far as the present season is concerned this seems to be precisely the case, and the Kidney Hybrid has so far shown many of the other characteristics which are necessary to make it compare favourably with Sea Island, that is *from a grower's point of view*, but the variety, has not been properly fixed to type and a few individual plants show signs of reverting to one or other of the parent plants and it will be necessary to continue with plant selection work until the type has become commercially pure.

For the ultimate fixing of a commercially pure type, the method adopted by most plant breeders is that of the "progeny row" system, which is one based on the separate raising of progeny of individual selected plants. To begin with several plants are selected as being the best to be found, and the seed from each of these is saved separately. The reason for having more than one plant to start with is that the degree to which the characters

of the parent are transmitted are found to vary with different plants. The following year each of these lots of seed is used to establish a row of, say, one hundred plants. The rows should be adjacent to each other and should either occupy an isolated position or be placed amongst cotton of good type. These precautions are taken to prevent, as far as possible, the crossing with pollen from inferior plants. Any plants of noticeable inferiority are pulled up as soon as detected. When plants come into bearing the rows are compared with each other, and the rows which possess the required characters with the greatest regularity are selected. In these again a number of the best plants are marked and the seed from each individual saved separately for next three years' rows. The seed from the remainder of the plants in each selected row is saved and used for planting separate plots, while that from the non-selected rows should also be kept for planting since it may be expected to be above the average. The following year there will be:—

- (1) a new set of rows from the last selected plants;
- (2) as many seed plots as there were selected rows in the previous year;
- (3) a certain amount of cotton planted from seed from non-selected rows.

For reasons connected with crossing already indicated, the seed plots should be planted around the rows. The selection of rows and individual plants, and the planting of seed plots, are repeated in this and each succeeding year. From the seed plots sufficient seed will be obtained each year to plant out a large field. If the seed from this is not sufficient for an isolated community of growers, the process can be carried on another step, using the area upon which the seed cotton is grown as the seed plot for the following year.

A study has been made of the behaviour of each hybrid plant in the progeny rows. All the free-seeded ones were grouped together and careful observations made. Points such as pest resistance, productivity, size of boll, length and uniformity of staple and flower colourings, &c., were noted.

Two plants were selected as being the most uniform and desirable and the seed obtained from these has been planted on increase plots at the Station. Seed from the former, namely K. 3-2., has been chosen for distribution to growers during the current season. This means that the seed from an individual plant has in two years been multiplied up to meet the requirements of all cotton growing areas in the Sigatoka district, roughly 600 acres.

The type of plant which we are attempting to produce is a robust one of open habit, with full opening bolls and strong lint of uniform staple length, resistant to Black Arm *Bacterium Malvacearum* and other fungi encouraged by excess of wet and humidity of which we have so much here. It appears to me that our safest plan would be to produce two types:—

- (1) a coarse stapled cotton measuring about $1\frac{1}{4}$ in. which could be used for mixing with wool;
- (2) a fine stapled cotton measuring about $1\frac{1}{2}$ in. which could be sold against Egyptians.

At the present time both of these types are selling well in the English market. To my mind it is desirable to have as it were, two strings to our bow, so that should one type drop in price we would have a supply of seed from the other and would be able to put it on the market in a short space of time. There is always a danger of wool prices having a direct influence on the price of the rough cottons, and of over production in Egypt and the Sudan influencing the price of Egyptian types. All selection work at the Station has been carried out with this end in view. The best of the coarsest counts have been selected, self fertilized, and planted out on isolated plots in progeny rows.

Self Fertilization.—In order to ensure self fertilization it is necessary to take the flower buds during the evening or early morning before they burst open, and by means of a silken thread being securely tied around the corolla they are prevented from opening. One end of the thread is attached to the stem above the peduncle. The flowers of cotton plants are known to a botanist as complete in that they possess both male and female organs necessary for reproduction. During the afternoon of the following day the stigma becomes receptive and fertilization takes place. No pollen from the surrounding plants has been allowed to enter as the flower has never opened. After about three days the corolla withers up, drops off and hanging by the thread, which as I said before had been attached to the stem above the peduncle, it acts as a label.

In order to obtain the fine type, we have back-crossed selected plants with Sea Island and the seed obtained has been planted in single lines where it will be self fertilized and again selected from during the coming season.

Crossing.—Crossing is a much more tedious business and can only be done by a person who has been thoroughly trained to the work. Flowering buds are taken two days before they are due to open. One petal is removed by means of a fine pair of scissors. The flower is then emasculated, care being taken to see that the anthers have all been removed, and in order to ensure that it cannot be visited by pollen-carrying insects, the flower is then covered by a thin paper bag. On the following afternoon a few flowers are taken from the plant chosen for crossing and pollen from them is placed on the stigma of the emasculated flower. The bag is then replaced and not removed for two days when the young boll is labelled by means of a piece of coloured thread being tied around the peduncle.

Dr. S. C. Harland, Geneticist of the Corporation's Research Station in Trinidad, has kindly supplied some seeds from a Kidney Sea Island Hybrid which has been back-crossed with Sea Island. These have been planted out and their behaviour will be watched with interest. In comparing the two varieties I have taken the highest plot yields obtained last season at the Station for each. With regard to Sea Island I have taken the average price obtained for all grades since the recommencement of the industry, and an estimated average price for the new cotton. Working on this basis we find that—

(a) one acre Sea Island yielded 1,228 lb of s/c at 3·05d.=£16 8s. 8d.

(b) one acre New Variety yielded 1,794 lb of s/c at 2·5d.=£18 13s. 9d.

In two years we hope to bring the quality of the new variety up to an average value of 13½d. per lb. The average purchasing price of one pound of lint at the present rate is estimated at 7½d. The cost of ginning and marketing on a 918 bale crop in 1926 was 5·13d. per lb. This means that should we reach our goal a profit of ·87d. plus the prices obtained for cotton seed would be made on every pound of cotton sold.

Judging from reports received from the British Cotton Growing Association there is likely to be a constant demand for up to 10,000 bales of this variety, whereas if we were to produce more than 1,000 bales of Sea Island we would probably flood the market, but at the same time, it would be advisable to keep a stock of pure Sea Island seed on hand in case there should be a good demand for it at some future date, and it should prove more profitable to the growers than the new type. In order to do this it would be necessary to confine an isolated area to the growing of it exclusively and to gin and store it separately. At present it is being grown between Ra and Cuvu and stored and ginned at Lautoka. My own opinion on the matter is that

we would be able to dispose of up to 2,000 bales of Sea Island cotton at a price which would pay both the grower and the ginner, but it is a variety which would not be grown extensively by Fijians, mainly because it is a difficult cotton to pick and needs to be carefully picked over again before it is forwarded to the ginnery, and I am afraid that the work would prove to be too tedious for the Fijian temperament.

If cotton is to be grown by Indians alone it would be a considerable time before the output exceeded 1,000 bales, because consolidated areas settled by Indians who are not engaged in growing either sugar cane or pineapples are few and far between and on account of transport difficulties and costs, it could not be grown profitably by those whose holdings are situated at any great distance from the ginning centres. I am therefore in favour of confining Sea Island to the districts between Ra and Nadi on the western coast where it can be dealt with at the Lautoka ginnery and there need be no fear of the two varieties being mixed.

With regard to the new variety (which can be picked twice as easily), Fijians, if given a little encouragement and training, should be quite capable of producing up to 500 bales in the districts of Nadroga and Colo West alone. Each year they are becoming more and more interested and it is encouraging to see that a number of them have been growing cotton for the last three seasons. In order to stimulate their interest it might be a good thing for the province to provide villages with agricultural implements on the understanding, or rather, written agreement, that the implements would be paid for from the proceeds of the crop at the end of the season. The time limit for payments might be extended over one or two seasons according to the area and yield of the crops concerned. Having firmly established cotton growing on this island we would be in a position to concentrate on some of the other islands.

An important fact which should not be lost sight of is that it is not advisable for a grower to depend upon cotton alone for his livelihood. It should be grown in conjunction with other crops and rotated with a legume. At present with perhaps the exception of tobacco, other than perishable crops, such as maize and tomatoes, there are not many being grown. In order to encourage the growing of them it would be advisable to extend the area of the Cotton Station and to make a general experiment station of it, where crops such as ginger, sehna, turmerik, groundnuts and onions might be thoroughly tested and distributed to growers if found successful.

His Excellency.—I am sure we all appreciate Mr. Anson's interesting paper and I think, perhaps, that he has not gone far enough in explaining the steps he has taken for the practical application of his teaching to the Indians of the country. I fully endorse what he has said about agricultural implements. I know that Mr. Anson is proceeding on the lines I mentioned this morning. I agree that it is a good thing to put people on the land, to assist them with practical demonstration and to teach them how to rotate their crops. I think valuable work is being done in this direction. I invite discussion on Mr. Anson's paper.

Mr. Field.—I should like it to be clearly understood that the cotton industry is still in an experimental stage. It is now seven years since the revival of the industry; this may seem a long time. The reason for this protracted experimental stage, which should be completed in another two years, is on account of Sea Island cotton having been planted in the first place. This variety has the longest and finest staple that can be produced anywhere in the world, and on account of these qualities it is the most

expensive. The demand for this variety within the past seven years has been limited, and there was some difficulty in disposing of the small Fijian crop. It has been estimated that owing to the falling off in demand for this cotton, it might take as long as eighteen months to two years to dispose of a crop of 2,000 bales after delivery in the United Kingdom. The prices realised up to date for Sea Island cotton have been most profitable to all concerned. However, this has not altered the position and it is still considered to be an unsatisfactory variety to grow as there is the risk of the industry being "saddled" with large stocks of cotton unsold in the United Kingdom. The British Cotton Growing Association advises trying out other varieties and the selection of one that will suit the climatic conditions of Fiji, be remunerative to the grower, and for which there should be a regular demand. This naturally takes time as selection work and cross-breeding, even with the best of luck and under the most favourable conditions, can seldom be achieved in less than from five to six years. Owing to these experimental stages the industry has been more or less held in suspense, and in consequence the preparation, ginning and marketing of cotton in Fiji has been held back and it cannot be said to have reached an economical position from a commercial point of view. Nearly all varieties of cotton have their ginning peculiarities, that call for different types of ginning machinery. Until it has been definitely settled which variety is to be grown generally in Fiji and the crop reaches 1,000 bales, the ginning and preparation of the cotton for export will have to be carried on with the existing plant which is only suitable for Sea Island cotton, but can be made to gin other varieties, though not on commercial lines or on a profit-making basis.

[Mr. Field then described in detail the lay-out and method of operation of the two existing ginneries, one of which is at Lautoka, and the other at Sigatoka].

Mr. Tarby.—Indian cultivators in other islands of the Group are capable of producing cotton and many of them are anxious to do so. How long will it be before this crop can be extended to those places?

Mr. Anson.—We hope first to make a success in this island before dividing our forces. Increased overhead charges and expenditure which would be necessary would be disastrous to the industry at the present time. As soon as we have fixed our policy here and made a success of it, which will take two more years at the least, then we can extend to the other islands. There is really no reason why growers should not plant up on other islands, but the cost of getting the cotton to the ginners would be greater than the profits reaped by the grower under present conditions.

Mr. Hunt.—What would be the possible return per acre for cotton. We have figures for certain varieties which returned £16 8s. 8d. and £18 13s. 9d. respectively.

Mr. Anson.—The average yield of the new variety would work out between 750 and 800 lb per acre. The average price received by the grower is 2½d. per lb and the return would be £7 or £8 per acre. That is for the new variety.

Mr. Hunt.—What would be the cost of production?

Mr. Anson.—At the Experiment Station the cost is probably a little on the high side. There it works out approximately £3 7s. 6d. per acre.

Mr. Hunt.—Is the cotton industry supported by the Government at present or is it running on its own merits?

Mr. Anson.—The industry is running entirely as a commercial concern at the present time. The prices have been fixed by Government. The

IMPORTS AND EXPORTS DURING THE YEARS 1923-1928.

Article.	Year 1923.	Year 1924.	Year 1925.	Year 1926.	Year 1927.	Year 1928.	Average for 6 years.	Percentage to total Imports and Exports.									
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	%	1923. Value.	1928. Value.	Average 6 years Value.					
Total Imports .....	...	£ 988,029	...	£ 1,065,874	...	£ 1,263,486	...	£ 1,464,177	...	£ 1,215,612	...	£ 1,455,090	...	£ 1,242,045	£	£	£
Rice*	206	3,269	658	10,992	149	2,449	2,390	38,448	757	10,837	1,218	18,994	886	14,135	0.33	1.31	1.14
Sharps*	3,194	32,561	3,695	35,618	3,475	40,564	4,010	51,143	4,210	47,549	4,050	47,575	3,772	42,507	3.28	3.27	3.42
Dhal*	112	1,342	180	2,199	281	3,939	286	4,518	283	4,078	354	5,781	249	3,643	0.14	0.40	0.29
Mustard Oil*	150	6,825	207	11,383	163	9,699	202	11,003	165	9,462	169	8,423	176	9,466	0.69	0.51	0.76
Ghee*	58	3,665	98	6,818	68	1,565	85	5,452	114	6,991	134	7,103	94	5,785	0.37	0.49	0.46
Spices*	17	800	19	1,204	17	1,207	25	1,190	14	695	23	1,574	19	1,111	0.08	0.11	0.09
Potatoes and Onions*	1,291	11,340	1,530	13,883	1,255	14,505	1,418	15,546	1,506	10,113	1,790	14,346	1,465	13,239	1.15	0.99	1.07
Total, Value ...	...	59,832	...	81,797	...	73,928	...	127,300	...	89,727	...	103,796	...	88,896	5.05	7.13	7.15
Total Exports .....	...	£ 1,461,518	...	£ 1,442,215	...	£ 2,107,014	...	£ 1,647,364	...	£ 1,930,208	...	£ 2,633,238	...	£ 1,870,259	...	...	...
Sugar	44,108	866,287	44,470	768,110	91,744	1,371,267	56,991	808,195	72,752	1,125,215	120,683	1,827,095	71,791	1,127,695	59.27	69.39	60.30
Molasses	8,392	4,783	8,283	4,783	8,283	7,374	11,181	11,181	11,181	14,599	14,599	14,599	8,602	8,602	0.58	0.55	0.46
Copra	24,161	443,445	23,137	484,496	24,133	497,713	27,868	573,475	26,500	534,416	27,947	567,254	25,624	516,633	30.34	21.54	27.62
Coconuts	45	1,119	52	1,613	45	1,420	25	1,107	64	1,160	33	600	44	1,169	0.08	0.02	0.06
Coconut Oil	538	10,174	74	2,977	132	5,026	91	4,387	79	3,357	101	4,421	136	5,057	0.80	0.17	0.27
Bananas	8,182	94,325	9,357	115,246	11,312	132,491	11,288	138,040	10,884	157,819	10,432	147,781	10,232	130,950	6.45	5.61	7.00
Cotton	15	3,530	28	9,255	22	5,128	147	32,134	64	13,733	25	4,742	50	11,420	0.24	0.18	0.61
Cotton—Output at Factory ..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Cotton Seed	43	5,128	83	7,416	66	16,116	419	23,581	190	15,276	42	4,704	143	12,042	0.35	0.18	0.64
Rubber	40	2,088	129	1,408	64	3,665	269	3,277	190	2,124	153	1,703	196	2,397	0.14	0.07	0.13
Pineapple (fresh)	174	...	62	2,192	63	1,807	42	1,201	168	4,924	111	1,567	89	2,338	...	0.05	0.12
Mauritius Beans .....	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Maize .....	...	2,529	6	47	55	348	41	271	69	416	...	...	...	270	...	...	0.02
Vegetables	192	2,604	294	2,572	242	3,171	525	4,958	361	3,717	457	6,169	348	3,852	0.17	0.23	0.21
Biscuits	51	...	149	7,788	215	10,429	202	9,095	168	9,334	195	11,306	163	8,426	0.18	0.43	0.45
Butter .....	...	25,427	...	...	10	1,881	26	3,616	24	3,615	15	2,269	19	2,670	...	0.09	0.14
Various (value) .....	...	...	...	36,391	...	52,437	...	50,707	...	38,581	...	38,221	...	40,294	1.74	1.50	2.15

* Principal Indian foodstuffs.

prices for Sea Island are 4d., 3d., 2d. and 1d. per lb; the prices for the new variety are 3½d., 2d. and 1d. per lb.

His Excellency.—*I understand that the Government gives a fixed price for the cotton. What is the Government's position when it has sold the cotton?*

Mr. Field.—The Government purchases the cotton from the growers at approximately 75 per cent. of its estimated value. After the cotton has been sold and Sales Accounts come through, and all costs have been deducted, the balance is distributed to the growers. I think what Mr. Hunt wanted to know is whether the Government subsidises the cotton industry. The industry is run entirely without Government financial assistance, although I believe the Government gave a grant of £700 at the beginning of the enterprise. Last year there was a loss of £513 which is the first loss since the industry commenced. There was a profit of £8,000 for the 1926-27 crop, when 919 bales were shipped. This profit was distributed as a deferred payment; nothing was placed to a reserve and the cultivators derived the maximum benefit.

Mr. Turbet.—The cultivation of cotton is important from the point of view of obtaining cotton seed for concentrated food for cattle. Mr. Anson states that one company has taken ten tons of seed and are very satisfied with the results. In 1928 I undertook some cattle feeding experiments in Suva with cotton seed and I found that all the animals did well on it. I think cotton seed is a valuable additional food for working stock. I do not know what has been done in the way of endeavouring to crush the cotton seed for the extraction of oil and the manufacture of cotton seed meal.

Mr. Barnes.—The remarks of Mr. Turbet are very interesting, calling attention as they do to the value of cotton seed for cattle food. I would refer him to recent work in America where experiments have been carried out in this connection. With regard to the crushing of cotton seed, one farmer in Suva recently endeavoured to get cotton seed crushed at the local oil mill, but unfortunately they were unable to take the work. Their machinery is adapted for special purposes and an experiment of that nature would disorganise certain sections which is hardly an economical proposition from their point of view. If a steady supply were assured the necessary arrangements could probably be made.

His Excellency the Governor.—*I will now request Mr. Stuchbery to read a paper on the Dairy Industry.*

PROGRESS OF THE DAIRYING INDUSTRY IN FIJI.

By H. M. STUCHBERY, B.V.Sc., Acting Senior Veterinary Officer.

It is now about seven years since the dairying industry was established in Fiji and a review of the progress made during this period may be of interest. It is intended to confine attention chiefly to the progress made in regard to the class of cattle among those herds supplying butter-fat to the three factories, Tailevu, Rewa and Navua, and to the general methods of management by dairymen. It must be borne in mind that there are besides these herds many other herds concerned in the production of milk and butter in which much improvement has taken place, although not perhaps to the same extent as has occurred in those herds supplying these factories. Before the Tailevu dairy scheme was started very few pure-bred stock of a milking strain existed in the Colony. The following figures give a fairly accurate summary of the state of these herds to-day:—

			<i>Tailevu.</i>	<i>Rewa.</i>	<i>Navua.</i>
Number of herds supplying cream to factory	..	..	23	15	14
Number of herds using pure-bred bulls	..	..	10	15	9
Number of herds containing pure-bred cows	..	..	..	11	4
Number of years factory has been established	..	..	7	5½	4

It is safe to say that 90 per cent. of the remainder of the herds use good grade bulls as sires. Generally speaking, too, it is only the small suppliers who are not making use of pure-bred sires. A statement to the effect that in no other Colony would we find such a large proportion of pure-bred stock would be difficult to contradict. It must be remembered also that there are other breeders of pure-bred stock in Fiji who are not included in these figures.

When considering the progress being made in the dairying industry, sight must not be lost of the fact that at the outset these herds were built up hurriedly from whatever stock was available. While many of these may have been quite suitable for the purpose, a great number coming as they did from untried stock, must have been entirely unsuitable and unprofitable. It has fallen to the owner therefore to eliminate these unprofitable cows from his herd, a task which takes years to do in many cases on account of lack of capital and difficulty in obtaining good cows to replace the unsuitable cows. The following figures of the production of cows in the Rewa area may be of interest. These were supplied by the Manager of the Rewa butter factory. These figures were obtained from cows whose morning and evening milk was weighed, sampled and tested:—

30 cows yielded over 50 lb butter-fat in 30 days.					
10	do.	40 lb and under 50 lb	in thirty days.		
76	do.	30 lb	do.	40 lb	do.
289	do.	20 lb	do.	30 lb	do.
141	do.	12 lb	do.	20 lb	do.
10	do.	under 12 lb	..	do.	

It will be seen that in the Rewa there are still a large number of unprofitable cows in the herds. These figures are taken whilst the cows were in full milk so that their average yield per month for their full milking period would be considerably below this figure. It can be taken for granted therefore that any cow showing a lower production than 20 lb per month in these tests is unprofitable. The same proportion of unprofitable cows would also exist in the Tailevu and Navua districts. It might be said that such a proportion of unprofitable cows does not reflect creditably upon the owners, but several facts must be borne in mind, namely:—

- (1) owners have not yet had time to cull their herds sufficiently;
- (2) it is difficult for these owners to avail themselves of a subsidiary industry while their herds are being built up;
- (3) it is better to have even a bad cow producing a small quantity of butter-fat than to have no production at all.

Dairymen on the whole are quite aware that a number of unprofitable cows do exist in their herds and they are fully alive to increase in profit which could be made with better cows. From the herds of such owners we can expect an increasing yield per cow in the future.

In the dairying industry an important step towards success is supplementary feeding with concentrated foods. Where pastures are of a high nutritious value this factor is not of such vital importance. Whilst pastures are very prolific in our dairying areas in Fiji, it cannot be denied that they are rather low in nutrient value, and hand-feeding foods is sure to be beneficial. In Fiji the supplementary foods obtainable at a reasonable cost are rather limited. The only concentrates at present in

use are coconut meal, rice bran and molasses. Quite a number of dairymen are using these with beneficial results and the number of these users is bound to increase when the benefits obtained from the use of these foods become more widely known, and it would appear that secondary industries producing concentrated stock foods as by-products should find a ready sale for these. At present difficulties of transport and the cost of same, place some dairymen at a disadvantage in the use of these foods, but time will lessen these problems.

In most dairying countries, supplementary industries to the production of butter-fat are an important part of the dairying industry. Up to the present, dairymen in Fiji have not developed this section of the industry to any great extent, the rearing of young stock for butchers purposes being practically the only sideline to the industry. The raising of swine for local butchers purposes offers a good field of investment as between 60 and 70 pigs are imported each month for this purpose. A praiseworthy effort is being made by the Fiji Pastoral Company Limited to capture this market, and up-to-date piggeries have been constructed to provide for the breeding of pigs on a large scale. The Suva butchers are anxious to obtain locally-bred pigs as it will not be necessary for them to retain such a large number of pigs at their yards against the next shipment from overseas. At present, however, it would never do for all our dairymen to go into the pig raising industry as the supply would soon exceed the demand. The production of bacon in connection with dairying industry is, however, a source of great profit and the establishment of a bacon curing factory is within the bounds of possibility if our dairying industry continues to expand. The establishment of any industry which will absorb by-products of the dairy industry is sure to benefit and stimulate the dairying industry considerably.

While it is apparent that good work has been done by the pioneers of the dairying industry, often under adverse circumstances, we must not lose sight of the fact that much can still be done to make the dairying industry more productive and profitable. The following points commend themselves for consideration in the future of the industry:—

- (1) more extensive testing of dairy heads with subsequent elimination of unprofitable cows;
- (2) the improvement of pastures by the elimination of weeds and pests, and the introduction of nutritious fodder plants;
- (3) a wider adoption of the principles of handfeeding with concentrated foods;
- (4) the development of secondary industries which will benefit the dairying industry;
- (5) the adoption of the most up-to-date methods of handling of dairy produce with the strictest attention to all sanitary precautions, necessary for the production of only the purest dairy products.

The successful adoption of all these measures does not lie entirely with the dairymen, and any assistance that can be given to this body of men will ultimately reflect on the prosperity of the Colony.

Butter Production in Fiji.—The following figures taken from the Fiji "Blue Book" give the butter production from the butter factories since 1921:—

Year.	Amount.	Year.	Amount.
1921	15,104 lb	1925	168,844 lb
1922	23,785 lb	1927	302,513 lb
1923	59,219 lb	1928	313,655 lb
1924	143,219 lb	1929 (estimated)	357,000 lb

The 1929 figures are estimated from the production of one factory for 1929 compared with the previous year. It will be noted that there has been a constant and rapid increase in the production of butter every year. The increase in 1928 was certainly only slight, but it must be remembered that the latter half of 1928 was exceedingly dry, and the butter-fat production decreased accordingly.

His Excellency the Governor.—I congratulate Mr. Stuchbery on his interesting paper relating to this important industry. I think the figures which he quoted make most heartening reading. When I was in London I was told that the Fiji butter was just as good as the best New Zealand butter.

Mr. Turbet.—In opening the discussion on Mr. Stuchbery's paper I would first of all like to compliment him on the able manner in which he has reviewed the dairying industry. Fortunately, I have had an opportunity of reviewing his paper. Although it is not lengthy it has the advantage of covering the ground concisely and giving a good lead in the concluding points for a discussion as to the best methods of fostering and improving the industry. Let us consider Mr. Stuchbery's points.

The first is, "A more extensive testing of dairy herds with subsequent elimination of unprofitable cows." The testing here referred to is the recording of the daily and total yield in milk and butter-fat for each cow over a given period, which might be a month or the usual milking period, about 273 days, or a whole year. An accurate record of these returns enables the farmer to ascertain the relative economic values of his cows. Where concentrated feeding is resorted to it can be ascertained whether the cows are giving a fair return for the value of the concentrates used. In the breeding of dairy cattle also, the returns of the cow as revealed by the herd tester give a most accurate guide for the selection of the most profitable animals. In these times when it is hardly the practice to rear all calves born on the farm, those heifer calves, at least, of known high producers should be raised with extra care as on those animals depends the future herd. In larger countries than Fiji it is usual to employ herd testers, either by the Government or by Herd Testing Association. Such an appointment may not be warranted here yet, but good work in that direction is being done by the managers of the butter factories.

The second point is, "The improvement of pastures by the elimination of weeds, pests and the introduction of nutritious fodder plants." If I were to be asked what is the greatest enemy of agriculture and the live stock industry in Fiji? I would reply, "The rapid growth of noxious weeds." I need not dwell on that; the curse of noxious weeds is too well known to all present. Apart from control of weed pests by biological means the only solution to the problem seems to be in limiting the size of the holding to such dimensions that it is within the power of the occupier, either financially or physically, to cope with the annual crop of weeds. Once having cleared his holding of weeds, weeding must be considered as a periodically recurring event in the routine of the farm and in preparing the estimates funds must be provided for that work. The only means of checking weed growth on Fijian-owned land and on large holdings such as Vitilevu Bay, once the weeds invade the district, is by keeping as much of the country as possible covered with the virgin vegetation of the region. Only such areas as can be kept in control should be used. It seems to me of little use experimenting further with grasses and fodder plants of temperate zones. That has been done for decades and I think it can be safely

assumed that all those which will grow are already here. It is in the other milder tropical countries that we should search for such plants. Older established and well-organised tropical countries such as Jamaica, Hawaii and the Philippines no doubt contain many useful fodder plants suitable to our climate which have not yet been introduced here.

The third point is, "A wider adoption of the principles of hand-feeding with concentrated feeds." The concentrates available in Fiji are:—Rice Bran, Coconut Meal and Cotton Seed. Rice bran and coconut meal have been well tried and those dairy farmers who use these concentrates are awake to the increased yield of milk and greater profits which accrue from their use. I have recently had an opportunity of visiting many dairy farms in Australia. I found that all dairies in the vicinity of Sydney are relying solely on hand-feeding, whilst in the country districts many farmers are feeding at least a ration of concentrates. Nearly every farm of any consequence has also installed one or more silos. In this country where it is impossible to store feed as hay I think that the silo offers the best means of storing the better classes of bulk feed or roughage for winter feeding. Maize has been found excellent for silage purposes, but most grasses and herbage can be used. The feeding value of silage is high and it enables dairy cows to produce milk and butter-fat more abundantly. It is estimated also that the use of silage will increase the carrying capacity of a dairy farm by about 25 per cent. The cost of construction is considerable as probably only the tub silo would be efficient in the country. Before recommending their general construction I think that one should be built experimentally. That is a matter which could be gone into further. A feeding experiment with local cotton seed was conducted a few years ago. There is a record of that in the department. The results showed that there was no harmful effect from the feeding of the seed and the animals certainly improved in condition and growth as compared with the control. The matter of crushing the seed locally was gone into, but, I think, found too expensive; however, the whole seed offers a further choice of concentrated feed for our dairy stock. Those who do not feed supplementarily with concentrates should be guided by the experiences of those who do. No doubt there are some present who have had experience.

The fourth point is, "The development of secondary industries which will benefit the dairying industry." Our local dairy farmers have always been under a disadvantage in making their farms pay, as compared with similar farms in other countries. In those other dairying countries there are well-established secondary industries which help to augment the returns of the farm. Chief among these industries is pig raising. It would appear that there is no farmer or body of farmers in Fiji who can guarantee to the butchers a regular monthly or periodic supply of uniform healthy pigs. If that supply existed I am sure that butchers would purchase locally instead of importing. In other words the industry is not organised here. We have abundant feed suitable for pigs in Fiji among which might be mentioned, skimmed milk, maize, rice bran, coconut meal, broken rice, grasses and root crops. That is a fair selection. There is not time to go into the whole business of pig raising now, but I have no doubt that it can be profitably conducted in Fiji. The Veterinary Division is always prepared to advise from personal experience and from literature which is available in the Department. Bacon curing might also be considered as an extension of the pig raising industry. Skimmed milk enters extensively into the manufacture of margarine. The other ingredients of margarine are also produced in the Colony, such as fats and oils. There should be a good

market for the product in Fiji among our Indian community. Another consideration is the coagulation of the casein of skimmed milk, the drying of the same and its export. It is a valuable commodity and is used in the manufacture of many articles. The poultry yard and the banana plot are also valuable adjuncts to the dairy farm.

Mr. Witherow.—I would like to point out that coconut meal is unprocurable in Fiji. The Rewa dairymen were using about ten tons every month and suddenly the supply came to an end. Then there is the question of top dressing in Fiji. Fodder plants in Fiji grow very quickly compared with other countries where it is colder, and I think that this makes the nutritive quality in the grass less here.

Mr. Turbet.—There is no doubt that what Mr. Witherow says is correct, but there is the question of stock licks which is an alternative method of providing the extra chemicals required. We have always recommended stock licks and in co-operation with our Government Chemist we will now be able to ascertain the composition of our fodders and find which chemicals are lacking.

Mr. Hunt.—With regard to the dairying industry in Fiji there is no doubt that you can appreciate the benefit of that industry to Fiji when in seven years there is an increase from 15,000 pounds of butter to 318,000 pounds. I think I am speaking for all the suppliers and the men who are in the dairying industry, and I may say that we quite appreciate all our faults. We also appreciate what standard we can rise to, but in the majority of instances it is a matter that the exchequer controls. The heavy expense of keeping down noxious weeds is a serious handicap. [Mr. Hunt then referred to the Dairy Regulations drawn up by the Medical Officer of Health]. I hope that Your Excellency will afford the dairying industry every possible assistance.

Mr. Barnes.—Perhaps I may be permitted to deal with some of the questions just raised. Regarding the subject of noxious weeds, information has been received from Mr. Simmonds that he will be ready to leave Trinidad with a consignment of the Thrips by the direct steamer which sails from London on 5th February. He will be joining that steamer at Balboa and should reach here about the middle of March. Arrangements have been made for Mr. Taylor to return in time from Java to take over from Mr. Simmonds the work of introducing the Thrips. The old Government Experiment Station at Nasinu will provide an ample supply of the weed *Clidemia hirta* (Koster's Curse) on which to try out the Thrips when they arrive from Trinidad.

In regard to experiments with fodders and top dressings I may say that a small experiment is already in hand and that the Department will publish the results as soon as available.

The local manufacture of margarine has engaged my attention for some little time, since the question of supply to the Indian community of ghee came under consideration. This is a very expensive commodity and costs probably more than butter. It is in fact almost pure butter-fat whereas butter contains a proportion of water. If we can persuade the local Indians to use margarine in place of ghee it will mean the building up of a valuable secondary industry.

In regard to the stoppage of supply of coconut meal I was not previously aware of the fact that it was not locally available and that certain dairymen were anxious to procure it. I can assure interested people that steps will be taken to try to remedy this.

His Excellency the Governor adjourned the Conference until 2.15 p.m.

Conference resumed at 2.15 p.m.

His Excellency the Governor.—We will now continue the discussion on the dairying paper.

Mr. Blackie.—Mr. Stuchbery stated there is a marked improvement in the dairying industry, but I would like to point out that since assuming my duties as Government Analyst I have analysed 40 samples of milk, 60 per cent. of which were deficient in fat and solids not fat. Although undoubtedly many of these were adulterated, yet even the milk from dairies properly controlled, although conforming to Fiji requirements, which are of a fairly low standard, are not equal in my opinion to milk values obtained in New Zealand and Australia. Even two samples from pure-bred Jersey cows gave fat values lower than is usual for this breed.

Mr. Turbet.—The quality of milk is fixed for any particular cow, irrespective of what food she gets. What is altered is the total quantity of milk produced by the cow. In spite of this, however, the quality of milk varies according to the period which has elapsed since calving. It is difficult to explain why there should be a deficiency in any particular pure-bred Jersey cow.

Mr. Barnes.—This question was asked by Mr. Blackie at my suggestion. It is obvious that the quality of milk which is being supplied for public consumption in Suva at the present time is, in some cases, inferior, and it was thought that this would be a convenient opportunity to ventilate the question. Samples have been taken at the time of milking and brought to the laboratory under proper care. It was found that European dairies, which were carefully looked after, had a much higher fat content than the milk supplied by Indian dairies in Suva, where it is obvious that they do not receive attention that is demanded for a dairy supplying milk for public consumption. This is a most important matter from the public health point of view. If the figures which Mr. Blackie obtained are typical of the majority of milk that is available for human consumption then there is a possibility that the standard should be reconsidered. In my opinion the standard is already sufficiently low and it should be possible to maintain a much higher average content of fat.

Mr. Kiss.—Spoke about tests of cows varying at different times.

Mr. Stuchbery.—It is possible that something happened to the animal referred to to make it give a low test on one occasion. It was perhaps frightened by another cow before going into the bail, or it did not yield all its milk.

Mr. Barnes.—I would like Mr. Leaning to give his views on this question.

Mr. Leaning.—Referring to the question of testing, experience in New Zealand over a number of years shows that the testing of a cow once a month gives figures that agree fairly closely with the butter-fat return from the factory. In Fiji we have carried out a series of tests and I am very doubtful whether the average fat production per cow amounts to more than about 90 lb a year. This is very low indeed. Last month we had a record output for our Tailevu factory and the net production per cow worked out at 15.2 lb of butter-fat, which is representative of the whole. An article published by a Herd Testing Association in New Zealand showed that there was one herd of 76 cows produced 67 lb butter-fat per cow during the month, and the lowest yielding herd in the Association produced 18 lb. It was a herd of 37 cows and that shows that their lowest herd is equal to our best herds at Tailevu. This indicates that we should go in for testing more extensively than has been done in the past. We have offered the suppliers an excellent scheme. It is costing them nothing. All they

have to do is to take the samples and bring them to the factory where they will be tested free of charge. I have written to the Department of Agriculture in New Zealand, and the Director of the Dairy Division asking for all available information in connection with testing. When received this will be at the disposal of the farmers. Another point was raised this morning which I personally think is a good scheme. When I was in New Zealand I showed Dr. Thompson's Regulations to one of the prominent men in the dairy industry there and the only fault he could find with them was that they were not strong enough. Of course, they can be amended and brought up-to-date. The appointment of a Dairy Instructor is essential and it would assist the farmers in this way. It would be one of his jobs, if we were making second-grade butter, to go to the farmer and put him right. It might be his separator at fault. I tested a man's separator last week and I found that he was losing at the rate of £7 per month. No one in the dairying industry in Fiji can afford to lose £7 per month. It is unfortunate that some of the suppliers think the time is not yet ripe for the appointment of a Dairy Instructor. At the present time we are producing more butter than the local market can consume and if we want to compete with other countries we have to put a decent article on the market. It is no use our going ahead and sending away second-grade butter and trying to sell it against New Zealand butter which is equal to the Danish article. I think these matters should be gone into and the farmers should agree as a body to employ highly skilled men which will pay them in the long run.

Mr. Turbet.—In my opinion the cows supplying milk for local consumption do not compare with those supplying butter-fat because the land in the immediate vicinity of Suva does not appear to be suitable for pasturage. It would be much better if these dairies were moved from Suva into the country, say the Rewa valley.

Mr. Ginn.—I take it I am the largest individual supplier in Suva. I represent the Suva Milk Supply Company. I have sold milk for many years and I claim that the test of my milk is equal to the test of specially selected Jersey cows. My only difficulty is to get the quantity of milk. I am quite satisfied with the quality.

Mr. Hunt.—When dairy farming in Tailevu I found that 2.45 gallons of milk were required to make a pound of butter, whereas in Suva milk was sold for 6d. a quart. The Tailevu settlers are on a better wicket than the Rewa suppliers because the former place only required 2.45 gallons of milk per pound of butter, whereas the latter required 2.85 gallons.

His Excellency the Governor.—It may be that an example of hand-feeding which came under my personal notice in Hong Kong will be of interest. One large dairy there with several hundreds of head of cattle depended entirely on hand feeding. There was no pasturage at all and the cattle were only turned loose for exercise.

Mr. Barnes.—Summarising some of the salient points of Mr. Stuchbery's paper, together with those introduced by Mr. Turbet and those which have been brought forward by the members in the body of the hall, I am pleased to see the keen interest that has been taken and the very useful information that has come to light in the course of discussion. The main points of Mr. Stuchbery's paper are that the dairy industry is now firmly established as an agricultural industry of Fiji, that it has grown in seven or eight years to take its place among the more important agricultural industries, but there still remains much to be done. It has been admitted that we do not know sufficient about the feeding requirements of our animals. The

present discussion will be of great help to the Department, indicating as it does the lines of inquiry to be followed. We must all combine and work in close co-operation for the improvement of this important industry to the Colony.

His Excellency the Governor.—The next paper to be read is on the subject of Coconut Oil and Copra by Mr. Barnes.

COCONUT OIL AND COPRA.

By A. C. BARNES, F.I.C., B.Sc., A.M.I.Ch.E., Superintendent of Agriculture.

Vegetable Oils.—Vegetable oils are amongst the most interesting and valuable substances produced by plant life. Oil is found in the fruit, flowers, leaves and stems of many plants and the oils themselves are as diverse in characteristics and uses as the plants from which they are obtained. Some of the oils, known as volatile or essential oils, find a use in the manufacture of perfumery and flavouring essences. Others provide valuable human and animal food and still more find employment in the manufacture of soap and in the paint and varnish industries.

Coconut Oil.—From the point of view of the Colony of Fiji, the most important vegetable oil is coconut oil produced from copra, with which we are all familiar. Coconut oil is a vegetable fat and belongs to the non-volatile class of vegetable oils, or as they are sometimes known, fixed oils. They are used in both the edible oil and the soap industries. Coconut oil essentially consists of a combination of certain so-called fatty acids with glycerine in the forms chemically known as glycerines.

Fatty Acids.—The fatty acids themselves are interesting chemical compounds, ranging from formic acid, commonly occurring in the animal world as the irritant liquid secreted by ants, bees, wasps, and in the vegetable world occurring in the common nettle and other stinging plants. The next in that series * is acetic acid, familiar on the table in the form of a diluted solution known as vinegar. Much higher up in the series we come to palmitic acid which is a white solid at ordinary temperatures and is largely used in the manufacture of candles. Palmitic acid occurs combined with glycerine in many vegetable oils, but principally in palm oil which is the produce of the oil palm (*Elæis guineensis*) examples of which will be found in the Botanical Gardens, Suva. Glycerine is a substance with which we are all familiar. It is a heavy water white liquid used largely in the explosive industry and in medicine. Glycerine to a large extent influences the market price of vegetable oils during war time owing to its use in the manufacture of high explosives.

Alcohols.—Glycerine is a member of the alcohol series of compounds and is distantly related to the commonly occurring ethyl alcohol which we know in potable liquors like whisky, gin, brandy, &c. Alcohols are capable of combining with fatty acids to form substances known as esters. Thus, for example, amyl acetate, a pleasant smelling liquid, is formed by the union of amyl alcohol and acetic acid. This may be familiar to some of us by reason of the fact that it is largely used as a cement for celluloid. In these cases one molecule of the alcohol is capable of combining with one molecule of the acid because the alcohol has only one hydroxyl radical. Ethyl alcohol and amyl alcohol are monohydric alcohols. Glycerine, or to give it its correct name, glycerol, is a trihydric alcohol, that is, it has three hydroxyl radicals and is capable of union with three molecules of

* Actually there are five distinct series of fatty acids.

fatty acid. The resulting compound is known as a triglyceride. It has already been mentioned that when the union of an alcohol with a fatty acid takes place water is eliminated. Conversely the addition of water by special means to the ester or the compound of the acid and alcohol will split it up yielding as a result the original alcohol and acid as separate substances. This process, the breaking down of an ester into its component parts, is known as hydrolysis and is of great importance in connection with vegetable oils. It is in fact the basis of the soap industry.

Coconut oil, as we know it, is a clear pale yellowish liquid which will, however, solidify if the temperature falls below 24.5°C . Although it is a stable compound,* that is, a compound which is not easily broken down into its constituent parts, it is, nevertheless, susceptible to the action of chemicals and ferments, which break it down into fatty acids on the one hand and glycerine on the other. The process of hydrolysis, which is in effect, the addition of the elements of water to the oil, followed by the subsequent breaking up of the compound into the two parts already mentioned can be carried out quite readily. It is this comparative ease with which certain vegetable oils can be decomposed that renders it so necessary to prepare the raw material from which the oil is obtained with the greatest possible degree of care, always having in mind the exclusion of those factors which will tend to break down the oil and so reduce its market value.

Coconut oil in its pure state is neutral, that is to say, the whole of the fatty acids are in a state of combination with glycerine and the manufacturer of edible oil requires that the raw material, that is, the copra from which oil is expressed shall yield products as nearly neutral as possible. The soap manufacturer, however, is not so particular, more especially at the present time when glycerine is a drug on the market. What he requires are fatty acids which he can saponify by treatment with alkalis to form soap. In its natural state in copra the oil is much more readily decomposed than after it has been extracted by expression of the dried kernel of the coconut. From the time when the nut is first split until the dried copra reaches the oil mill it is liable to progressive decomposition if not carefully handled at every stage of its preparation and transport.

Decomposition of vegetable oils.—In certain vegetable oil bearing fruits such as the fruit of the oil palm the agencies which effect the decomposition of the oil are actually present in the fruit. Palm oil as it occurs in undamaged fresh fruit of the tree is neutral, but as soon as the fruit is bruised the oil cells in the vicinity of the bruise are ruptured and the oil comes in contact with what is known as an enzyme, which is the active principle of a ferment, and is immediately hydrolysed or transformed, by addition of the elements of water, into fatty acids and glycerine in their uncombined states. In the case of copra no such agency is present in the kernel and such decomposition of the oil as occurs is invariably the result of some introduced condition caused by careless handling and manufacture of the copra or exposure of the copra to the actions of enzymes or ferments from other sources. Apart from the disruptive action, as we may call it, of these enzymes water itself without any other assistance will very slowly cause the decomposition of certain vegetable oils. The presence of water is actually an absolute necessity for the process of hydrolysis to go on. This process, however, is greatly accelerated by the presence of the agencies already referred to, known as enzymes.

Effect of Moulds.—The common moulds which so readily grow on the surface of copra under damp conditions are fruitful sources of fat-splitting

* More correctly a mixture of compounds as it is a mixture of glycerides of several fatty acids.

enzymes. The damp surface of green copra forms an ideal developing ground for the innumerable spores of moulds which occur in the air having been derived from mature mould growths. Although the moulds develop comparatively rapidly they do take an appreciable time to reach a stage where their products are capable of decomposing the oil and their action in the early stages is entirely superficial. If, however, the green copra* is left undried in heaps mould growths develop with great rapidity and the infection spreads throughout the whole mass which quickly becomes a stinking heap of decomposed oily vegetable matter.

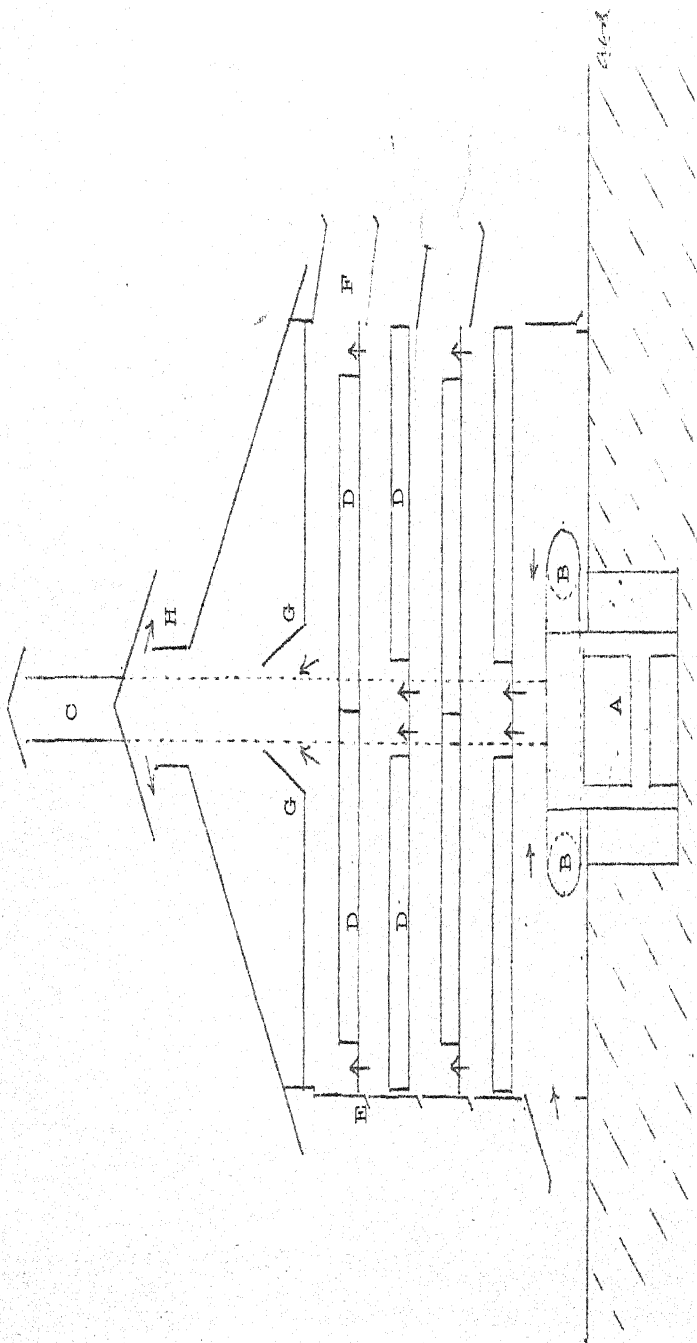
Rancidity.—A secondary action occurs after the original hydrolysis has commenced, resulting in the condition known as rancidity. Rancidity and the presence of free fatty acids in vegetable oils are often confused and it should be understood that although the one is a consequence of the other there is no similarity between the products which give rise to the two conditions. Rancidity is the result of the subsequent breaking down of the fatty acids liberated by hydrolysis under the action of moisture and air. The products formed are objectionable in flavour and odour and often give rise to considerable trouble in purifying the oil subsequently expressed from the copra. Highly rancid copra cannot be satisfactorily used in the edible oil industry. It is thus clear that the preparation of copra of good quality involves the careful exclusion of all conditions which will encourage the hydrolysis of the oil and the development of rancidity. The only way to do this is to dry the freshly cut green copra as rapidly as possible either in the sun or in a properly constructed and effective artificial drier. Green copra when freshly cut contains some 65 per cent. of water which must be reduced as quickly as is compatible with good quality of copra to somewhere in the neighbourhood of 5 per cent. if the product is to be free from more than a trace of free fatty acid. Though sun drying under ideal conditions is the best method of preparing high grade copra such a quality of copra can be obtained by artificial methods.

Drying.—The removal of moisture from vegetable matter in order to give a satisfactory grade of resulting product is not, however, so simple a matter as it would appear. Temperature conditions must be very carefully controlled, for if the drying copra is overheated chemical changes take place in the meat and the result is an inferior grade of product. Under no circumstances should the temperature be allowed to exceed 70° C. (158°F.) in the early stages of the drying. Overheating in the early stages of copra drying results in case hardening and moisture from the interior of the meat is prevented from diffusing as rapidly as it should to the outside layers, so that the copra appears to be dry when actually it is not. Such copra deteriorates seriously during storage and the shrinkage is of course, very high. By shrinkage is meant the loss of weight caused by evaporation of moisture. To illustrate the effect of over-heating vegetable matter in order to dry it rapidly we may consider the case of cane sugar which as is well known caramelises and turns brown when heated to a certain temperature. Starches and proteins undergo decomposition under the influence of heat and green copra which contains all these substances may be badly affected from over-heating during drying. In the design of kilns and hot air driers it is therefore necessary carefully to consider the question of temperature control.

Rate of drying.—The rate of loss of moisture from the drying copra is only partially dependent upon the temperature. Other important factors are the humidity of the air passing through the drier or over the drying

* The term "green copra" is used to denote the fresh kernel of the mature coconut.

DIAGRAM SHOWING "RUNNING VATA" ADAPTED FOR HOT-AIR
DRYING OF COPRA.



- A. Furnace.
 - B. Longitudinal flues.
 - C. Chimney.
 - D. Copra trays.
 - E. Shutters as arranged for hot-air drying.
 - F. Shutters open for sliding out of trays, for sun-drying.
 - G. Baffle.
 - H. Ventilator.
- Direction of hot-air currents.

copra and the rate of movement of the air current. Artificial driers for copra are familiar to most of us in Fiji. They are of several types, but in all of them the object is the same, that is, the removal as rapidly and as efficiently as possible of the excess moisture from the green copra. Involved in the question of efficiency is the quantity of fuel required to dry a given weight of copra, and it is here that there is still ample opportunity for research. Cartage of fuel to the drier is an expensive matter and when the husks of the coconut have to be supplemented by cut wood fuel artificial drying becomes very costly.

Sun drying.—The best method of drying the kernel and preventing more than the minimum decomposition of the oil is by exposure to bright sunlight in the open air, and it is in this manner that highest grade copra is produced. It is, however, by no means always possible to rely on weather conditions satisfactory for sun-drying, with the result that many methods of artificial drying, so designed in some cases as to facilitate the change over from sun-drying to artificial drying have been devised. Rainy weather is the bugbear of the copra maker. The large plantation owner overcomes the difficulty by using driers such as the "Chula," supplied complete by an English firm, or large locally-constructed driers of various designs.

Simple kilns.—The small producer also feels the need of some artificial drying kiln, and solves his problem by building a simple and usually ineffective erection which turns out a very inferior grade of copra. For example, in Zanzibar the kiln often takes the form of a shallow pit 8 or 10 feet wide, over which is erected a crude platform of branches and sticks. The kernels to be dried are piled on the top, and a fire started in the pit, the fuel being the husks of the coconuts. The product is black, insufficiently dried, and evil-smelling, and is quite unsuitable as a source of edible oil. It deteriorates seriously during storage and transport and commands but a low market price. An improved form of this type of kiln is in use, consisting of a low rectangular wall with a door at each end. The wall supports a framework of wood or iron rails which carries expanded metal or sticks and wire netting. This forms the platform on which the drying copra rests. The whole is covered by a thatched roof to keep out rain. Drying is effected by a small fire fed from each end of the large chamber under the platform, and hot air, mixed with the products of combustion, passes through the "kernels," which, though thoroughly dried, assume a dark-brown colour.

The objection to any kiln of this type is that the product is blackened by the smoke from the fire, and it is obvious that it is necessary to prevent access of the smoke to the drying material if the product is to be of good appearance. This can be effected with the kiln last described by making the platform of corrugated-iron sheets covered with clean sand, and by carrying off the smoke by a flue leading to a chimney near one end of the chamber. A simpler form of effective "sand-bath" drier consists of a channel excavated in the ground, with one end arranged as a fireplace and the other leading to a chimney, the channel being covered with sheets of corrugated-iron with sand on the top. The fireplace is closed in at the top by a layer of earth suitably supported, and the whole covered by a thatched roof. A number of such channels can be arranged radially around a central chimney. In situations where the nature of the soil is unsuitable for this underground-flue type, a similar effect can be achieved by building two, four, or eight chambers above ground, with flues leading to a common chimney, iron sheets covered with sand being used as before for the drying platform.

The three kinds of "sand-bath" drier described are under observation on one of the Government plantations in Zanzibar Island. They will effectively dry coconut kernels in 36 to 48 hours, the copra being of excellent appearance and practically indistinguishable from the best local sun-dried product.

DETAILS OF "SAND-BATH" TYPE COPRA DRIERS.

	Area of drying Platform Sq. ft.	Capacity Kernels*	Cost of erection.
1. Large chamber type	140	700	£15
2. Underground flue type	138	700	8
3. Small chamber type	135	700	8
(2 platforms)			

* Kernels in shell. After a few hours drying the kernels are removed from the half-shells and dried on the same kiln. Kernels from 700 nuts make about 230 lb dry copra.

From the brief description and statement of costs of erection, it will be seen that these kilns are suited to the needs of the small producer. For this class of user, it is essential that the type of kiln adopted should be inexpensive and capable of construction from material available locally.

Design of driers.—In proportion to the amount of copra dried the quantity of fuel required is large. Such kilns or driers would not be suitable for the requirements of the large scale producer of copra. With larger installations it is essential to ensure that the design provides for the proper and effective circulation of warm air throughout the drying material. Of the two types, that is, the one in which the copra is placed in the drier in bulk and the other in which trays are used to carry the copra in comparatively shallow layers, the latter is preferable. In the former case although hot air can be drawn or forced through most of the copra it is inevitable that the air will pass through particular channels and that where the material is closely massed together a baking effect rather than an air drying effect will be exercised. With properly constructed tray driers continuous and regular circulation of warm air over the whole surface of drying material can be assured with the result that a uniform product is obtained.

In many districts in Fiji the usual type of "running vata" could be modified with advantage to provide for hot air drying during wet weather, and to speed up drying by working at night during busy periods. The normal construction would need to be altered somewhat, but the additional expense involved should not be great. The sides and ends would require to be fitted with shutters which could be opened and closed at will in such a manner as to permit of the movement of the trays. Heating would be provided by a furnace set low at one end having one or more wide section flues passing underneath the lowest range of trays, well clear of ground level, to a smoke box and chimney at the other end. Ventilators would be fitted in the roof and the trays so arranged that effective circulation of warm air over the copra was assured. When in use as an artificial drier the lowest shutters only would be opened. Natural draught would draw in cold air from outside which would be heated by the flues, and traversing the trays of copra, would pass out through the ventilators. The general scheme is illustrated by the diagram.

Economic factors.—There is no doubt that the quality of copra shipped from Fiji is capable of considerable improvement with a consequent enhancement of its market value. The main factor affecting the value of copra is its oil content. Next in order comes the free fatty acid content, which determines to a great extent the particular industry in which the oil will be

utilised. The most important aspect of copra preparation is the effective removal of water. This controls the ultimate oil content of the product and, to a very large extent, the quality of the oil obtained from it. The exclusion of foreign materials is also important.

The solution of the difficulties facing producers in Fiji is largely in their own hands, but merchants and Government must assist by ensuring that copra of good quality is purchased and shipped as such and not mixed indiscriminately with low grade material. Fiji can produce copra of good quality and if the best grades of copra realised their market value, undoubtedly would do so. The introduction of grading would be of great help to the producers as they would thereby receive a fair market price for their product. Reference to the reports by the Imperial Institute, London, (Appendix of this paper) shows that copra of good quality, dry, and of low free acid content is worth from 10s. to 15s. per ton more than the low grade material of approximately the same moisture content.

At present the copra market is depressed and producers are discouraged. The industry in this Colony is poorly organised. Production costs are high, transport is expensive, and the general standard of quality very low. The modern cry is for "rationalization" of industry. Our copra industry needs such organisation in the direction of increased production, lower costs of preparation, handling, transport and marketing, and improved quality of our product. By directing our energies along these lines we should be able greatly to improve the position of the copra producers of the Colony.

APPENDIX.

IMPERIAL INSTITUTE,
LONDON, S.W. 7

REPORT ON COPRA FROM ZANZIBAR.

The samples of copra which are the subject of this report were forwarded to the Imperial Institute by the Assistant Director of Agriculture and are referred to in his letter No. A.D. 1181/28 of the 5th November, 1928. The samples were stated to represent four grades of copra produced in Zanzibar, and it was desired to ascertain their quality and market value. Nos. 1, 2 and 3 had been produced on Government plantations whilst No. 4 had been purchased from a merchant and represented the normal product of the native and Indian copra producers.

DESCRIPTION.

No. 1 Sun Dried.—Weight, 5 cwt. 85 lb. Bold copra of fairly good appearance, in the form of large pieces, mostly half-nuts. The inner surface was mostly very pale and internally the copra was free from discolouration. Many of the pieces were covered with green mould.

No. 2 Kiln Dried.—"Artificially dried on a kiln constructed of corrugated iron covered with a layer of sand, with a fireplace and flue underneath." Weight, 6 cwt. Pieces of copra very similar in appearance to the above sample No. 1, but on the whole of rather better colour and less frequently covered with mould.

No. 3 Smoke Dried.—"Prepared by drying on a platform constructed of iron rails and expanded metal over a large chamber with a fire door at each end. Coconut husks were burnt in the chamber and the products of combustion passed through the drying kernels." Weight, 5 cwt. 53 lb. Large pieces of copra (mostly half-nuts) of fair appearance, but in many cases covered with mould. The inner surface varied in colour from very pale brown to reddish-brown. Internally the copra was mostly free from discolouration. The sample had been slightly attacked by insects.

No. 4 Fair Average Zanzibar Quality.—Weight, 6 cwt. 27 lb. This sample consisted partly of half-nuts, but mostly of small pieces and dust. The copra was dirty and of very poor appearance, and was slightly attacked by insects. The inner surface of the pieces varied from brown to very dark brown, being chiefly dark brown, and was also mouldy. Internally most of the pieces showed discolouration for part of the thickness.

Results of Examination.—The samples were examined with the following results:—

	No. 1. Sun-dried.	No. 2. Kiln-dried.	No. 3. Smoke-dried.	No. 4. Fair average Zanzibar quality.
Moisture per cent	4.1	4.1	3.8	3.3
Oil in copra as received per cent	67.4	65.7	67.8	69.6
Oil in moisture free copra per cent	70.3	68.5	70.5	72.0
Acid value of extracted oil .	0.7	1.0	0.8	24.6
Free fatty acids (as lauric acid) in extracted oil, per cent	0.25	0.36	0.29	8.78

The oils as extracted from the copras with light petroleum were in general of normal appearance, but those from samples Nos. 3 and 4 had a yellowish tint.

The foregoing results show that the four samples all contained normal amounts of moisture, whilst the yields of oil compare favourably with the figure of 66 per cent. regarded as the minimum desirable for copra of good merchantable quality. Sample No. 4 (Fair Average Quality) contained the largest percentage of oil and No. 2 (Kiln-dried) the least.

The acidity of the extracted oils was very satisfactory in all cases with the exception of sample No. 4, the oil from which contained a high percentage of free fatty acids.

The three experimental samples, Nos. 1, 2 and 3 were all much better than the commercial sample No. 4 as regards both appearance and the acidity of the extracted oil. There was not much difference between the sun-dried sample No. 1 in appearance, but the former contained rather more oil which was of slightly better colour.

Commercial Value.—The samples were submitted to a firm of copra brokers in London, who furnished the following report:—

No. 1.—An exceptionally good delivery of F.M.S. Zanzibar, containing a few pieces slightly affected by mould and having the appearance of having been slightly overdried.

No. 2.—A very good delivery of Zanzibar copra, being clear and white in appearance. Would compare very favourably with Sample No. 1, with the difference that it seems to be hot air dried.

No. 3.—A good delivery of selected smoke-dried Zanzibar copra of particularly white and clean appearance.

No. 4.—A poor delivery of F.M. Zanzibar, of dirty appearance, and containing too much dust and small pieces.

The firm also made the following observations on the value of the samples and the market for Zanzibar copra:—

The appearance of samples Nos. 1 and 2 was very similar, except that No. 2 was a little whiter than No. 1. Both these samples were extremely good copra and very much superior to what is generally expected of Fair Merchantable Sun-dried Zanzibar. No. 3 was a very good smoke-dried copra and much superior to what is generally expected of this grade. Sample No. 4 had the appearance of ordinary Fair Merchantable Zanzibar which we are accustomed to seeing, except that it was of rather inferior quality, and a small allowance would have been given on same if arbitration had been claimed.

We notice that samples Nos. 1, 2 and 3 were produced on Government plantations, and no doubt this accounts for the greatly improved appearance and quality. We are perfectly sure that if the cost of producing copra up to this standard is not a great deal more, the producer would obtain a better price if the buyers were sure that they were going to get a good grade of copra, as per these samples. Zanzibar copra has always been known by the high contents of oil, but it has always been a very irregular description as compared with other qualities, owing to the variable weather, and very often Zanzibar copra, when it has been left out to dry, has got damp and this has caused it to become decomposed and dark in colour, this affecting the quality of the oil.

During the last year or so the best market for Zanzibar copra has been Genoa, where one or two crushers have been prepared to pay considerably better prices than anywhere else. These Italian buyers have used it, as far as we are aware, chiefly for soap-making, and therefore we rather doubt whether they would pay an extra premium for obtaining a higher grade quality, but to other ports, such as Marseilles, London, Rotterdam or Hamburg, where this copra is occasionally sold, the buyers would probably pay for samples Nos. 1 and 2 fully 10s. to 15s. per ton more than is usually obtained for ordinary Fair Merchantable Sun-dried Zanzibar, and 5s. to 10s. per ton more for sample No. 3 than is usually paid for Fair Merchantable Zanzibar; but it would be necessary first to let the various buyers (of whom there are a fair number) have samples of these grades, and also they might wish us to give some guarantee that any shipments made would be up to the standard of these samples.

The nominal value to-day of Fair Merchantable Sun-dried Zanzibar for April-May shipment to London, Rotterdam, Hamburg or Marseilles is about £22 15s. and that of Fair Merchantable Zanzibar £22 5s. per ton, but the Italian buyers would probably pay about 10s. per ton more to Genoa. We repeat ourselves in saying that to the first named ports we could probably obtain 10s. to 15s. above these figures for the present samples.

The market for copra has steadily declined during the past year, owing to the heavy shipments of copra generally from all producing countries, and at the present time is in a very dull state.

Remarks.—The results of this investigation show that the quality of Zanzibar copra could be considerably improved by more careful drying either in the sun or in kilns. The smoke-dried sample No. 3, although superior to the commercial product represented by No. 4, was inferior to the sun-dried and kiln-dried samples Nos. 1 and 2.

In the opinion of the brokers, copra similar to samples Nos. 1 and 2 would probably realise 10s. to 15s. per ton more than the ordinary fair average quality and No. 3, 5s. to 10s. per ton more. If these increased values are sufficient to render preparation by the improved methods remunerative, it would be advisable, when commercial quantities are available, to adopt the brokers' suggestion and forward large samples to the Imperial Institute for distribution to possible purchasers.

28th March, 1929.

His Excellency the Governor.—*Mr. Kermack is unfortunately ill and unable to attend the conference. I will ask Mr. Barnes to read the paper on Banana Cultivation in Fiji.*

FRUIT PRODUCTION FOR EXPORT—PART II,—CULTIVATION OF THE BANANA IN FIJI.

By JAMES KERMACK, Assistant Superintendent of Agriculture and Inspector of Produce.

Introduction.—The main object of this paper is to offer for consideration a few simple yet effective methods of cultivation which might readily be adopted in Fiji, where banana growing is now entirely in the hands of natives, whose system of planting and cultivating is generally speaking, primitive and crude in the extreme. Before, however, any suggestions are made, it might be well that a brief history be given of the industry in the Colony since 1914, when production of fruit reached its peak with shipments during that year, amounting to 1,715,766 bunches, equivalent to approximately 858,000 cases.

History of industry.—On the island of Vitilevu in districts where transportation is convenient and where probably soil and climatic conditions are more favourable to the production of first-class fruit than elsewhere in the Group, the banana industry in 1914 assumed considerable proportions and was more or less controlled by Europeans who by systematic cultivation, produced sufficient fruit of exceptionally fine quality to supply the demands of the Sydney, Australia, and Auckland, New Zealand, markets. A decrease of 700,000 bunches in 1915 due to a severe windstorm and floods in the latter part of 1914 apparently had not a depressing effect on the industry, as in the following year, production increased to within 65,000 of the record shipment of 1914. Unfortunately, the reactionary period was short lived and in 1917 effects of the introduction into or the development in the Colony of a fungus disease *Cercospora* locally termed "Sigatoka" the name of the district where it was first detected in Fiji, which attacked the leaves and in a short space of time defoliated the tree, were only too obvious through a considerable decrease in production of fruit during that year. Operating concurrently with the leaf spot *Cercospora* disease were "Bunchy top" (*Pentolonia negronervosa*), a virus transmitted by a small insect the banana aphid, the banana weevil borer (*Cosmopolites sordidus*),

the most serious insect pest affecting the banana plant in Fiji and "Banana Scab," the result of a deposit of larvae of a small moth which disfigures the skin of the fruit in its early stage, and experiments were immediately made by the Department of Agriculture in an attempt to control these different diseases and pest troubles by spraying and the introduction of parasites, but little or no success was met with. It is therefore not surprising that production of fruit in 1919 should drop to 614,722 bunches which is the normal requirement of the Auckland, New Zealand, market. In 1921, what amounted to an embargo on Fiji bananas through the imposition of a duty of one penny per lb by the Australian Commonwealth Government, shipments to that country were, with the exception of small consignments from time to time, discontinued, shippers considering that the high tariff precluded the possibility of a profitable market. New Zealand, the only other nearby available market, still offered possibilities but the limited quantity of fruit which a comparatively small population could absorb was evidently not sufficient for Europeans continuing operations and gradually their cultivations through neglect, possibly due to the high cost of necessary labour, were abandoned, leaving natives who had all along been associated with the industry, in the growing of small patches of bananas in conjunction with yams, dalo, &c., in their village provision grounds, sole producers. Banana growing with the average native, however, had been and to a great extent still remains a secondary consideration to the production of his staple food, yams and dalo, and whilst he probably realises vaguely that it means for him a source of revenue each month throughout the year, he does not look upon it from a commercial viewpoint, neglecting as he does the irregularly planted patches as soon as his provision crop is harvested. A steady decline in fruit production since 1921 was viewed with considerable alarm in 1927, and with the object of placing the industry on a better footing and to ensure a regular monthly shipment of from 20,000 to 25,000 cases to Auckland, a cleaning up of native plantations campaign was instituted by the Agricultural Department, the work, under the supervision of European Field Inspectors, who were appointed by the Government under the Diseases of Plants Ordinance, to be undertaken by natives at such times throughout the year as would not conflict with their communal operations. A degree of success was claimed in the initial stages, but it was latterly found that many, if not most of the fields were so badly infected with leaf spot disease and infected with the banana borer weevil that in order to save the industry a general planting up by natives of new areas was necessary. Additional Inspectors were appointed in 1928 and with the object of developing areas sufficiently large to ensure at least an export of the quantity of fruit already stated operations in the latter part of that year were commenced in the Wainimala, Wainibuka and Waidina districts on the island of Vitilevu, where it was considered stretches of rich alluvial river flats, isolated from old cultivations still existed. To date slight progress only has been made, approximately 330 acres having been planted with suckers which were carefully selected and examined by Inspectors for borer infection and whilst it is gratifying to know that the new fields which are gradually coming into bearing are yielding sound, marketable fruit, it is now realised from the fact fruit production during 1929 reached a low level of 185,000 cases or 370,000 bunches and falling short by some 80,000 cases of the minimum requirement of the Auckland market, that if a more active course of planting, systematic cleaning and pruning and draining of the land where necessary, is not adopted there is a grave danger that a valuable though comparatively small industry will be lost to the Colony.

SUGGESTIONS FOR IMPROVED METHODS OF CULTIVATION AND
HARVESTING AND TRANSPORTING OF FRUIT FOR EXPORT.

Selection of Land.—Selection of land which is near to convenient water or roadway transportation should be a first consideration of the prospective planter provided the soil is suitable. The nature of the soil can be more or less determined by its general appearance and as most agriculturists are or should be able to discriminate between poor and rich soils there is small necessity for a chemical analysis being made. The banana will grow on a great variety of soils, but apart from the rich alluvial river flats where the soil is ideal perhaps the best soil for its culture is a deep loam composed principally of sand and clay, and containing a good proportion of lime and humus. Humus, otherwise decayed vegetable matter, is highly essential to all plant life, probably more especially to the banana, through its supply of nitrogen. Care should be taken that the area selected for planting is well protected from high winds which tear and wither the leaves, thereby retarding the growth of the plant and for this reason steep hillsides on the weather side should, if possible, be avoided.

Preparation of Land.—Land should be prepared during the dry season and immediately prior to spring, which is the planting season. Clearing operations are comparatively easy during that period, but the tendency for convenience to burn the cut grass and bush should, unless it is extremely light, be discouraged, as by heavy firing a considerable portion of plant food may be lost through the destruction of the surface humus in the soil. Where practicable all grass should be dug into the soil, otherwise it should, along with the cleared bush, be removed to a place outside the area to be planted, and burned. Alignment of the field should be undertaken immediately clearing operations are completed, spacing the distances where the plants are to be placed not less than 12 feet apart, but preferably 15 feet, which allows for proper ventilation or air current, convenient cultivation of the land and ample room for the development of the banana roots which require a radius of from six to eight feet. Holes should then be dug where the suckers are to be planted, the depth of the hole varying with the conditions of the soil. In heavy soils a depth of $2\frac{1}{2}$ feet with a corresponding width should be considered, filling in with loose surface soil. This will permit of the roots getting a good start without having to unduly force their way, and the plant becoming thoroughly established in its bed in a comparatively short time. In free soil a shallower depth of, say, $1\frac{1}{2}$ to 2 feet would be sufficient.

Drainage.—Whilst an abundant rainfall is necessary to the satisfactory growth of the banana, good drainage is highly essential and it should be one of the first considerations of the planter to see that where there is a surplus of water in the soil, a system of drains is undertaken prior to the planting of his field. By doing so danger of the soil becoming waterlogged and air passages thereby blocked will be prevented. Where soil is light and porous drainage should be limited, as there is always a danger of making the soil too dry by overdraining. It must always be borne in mind that the principal object of drainage is to prevent stagnation of water in the soil. The method of drainage usually adopted in banana fields is by trenching to a depth of from three to four feet at distances varying from 30 to 60 feet apart, according to the nature of the soil. Sump drainage however, where the subsoil is of a porous character, could be economically undertaken and be quite effective by digging holes say four feet in width to a depth that would reach the porous strata in different places throughout the area. The sump system where practicable commends itself as no

subsequent attention is necessary, as would be the case with trenches, which require periodical clearing of fallen banana trees, leaves and other vegetable matter.

Planting.—Spring is the natural time of the year for planting, although operations may be continued during the early part of summer with a degree of success provided there is sufficient, but not excessive, rainfall. Every attention should be given to the selection of suckers which should be taken from plants which show vigorous and healthy growth. Great care should also be exercised when removing suckers, which should have about six months' growth, from parent plants. In the absence of the proper type of tool for this purpose, a cane knife is invariably used, but such method is inadvisable, as there is always a danger of injury being done to other suckers by what is termed "bleeding" or wounding by cutting which would retard growth and probably affect fruiting. The proper tool to use is a narrow semi-circular spade with which it is possible to sever the sucker with little or no risk of damage in the operation. After a sucker has been removed the roots should be trimmed, as also eyes cut off with the exception of one which would appear to be the strongest. It should then be cut to within six inches of the bulb and planted with the eye five or six inches below the surface.

Cultivation after Planting.—Fields should be kept entirely free of weeds and on this account considerable labour is usually expended by the planter in cleaning, either by hoe or plough. A method, however, which not only obviates to a great extent the necessity of weeding but also is a means of conserving moisture in the soil is mulching. Dry grass is effectively used in different countries where the soil is dry and rainfall low, but this form of mulching does not altogether commend itself where insect pests abound, as decaying vegetable matter spread over the surface of the soil might harbour them. The planter should have in mind the danger of the banana borer weevil in this connection. A system of green mulching or green manuring is generally accepted as a most economic means of controlling weeds and at the same time enriching the soil. Mauritius or any other beans might be planted immediately the land is cleared and would effectively act as a cover crop until cut down after seeding, when they should be forked or ploughed into the soil close to the plant during the dry season, when the soil is in a condition to be worked. By continuous and systematic cultivation, bananas in suitable soil should give good returns for a number of years. A field with plants, say, 15 feet apart or approximately 200 to the acre when properly cultivated should yield anywhere from 250 to 300 bunches per acre, 75 per cent. of which should be nine hands or over.

Pruning of Plants.—Pruning is one of the most important operations in banana culture and should be undertaken when the plant is young. Too many suckers attached to the root must necessarily rob the parent of a certain amount of food and for this reason it is desirable that a limited number should be allowed to grow and in time produce fruit. It will therefore be understood that the object of pruning is to conserve the vigour of the plant which is to produce the first fruit and at the same time assist the growth of its followers, which will eventually take the place of the former after the fruit has been reaped. Not more than three suckers, although two is more advisable, should be left to follow the fruiting plant, if possible at equal distances around the bulb. The suckers left as followers should be at different stages of development in order that no two plants will be fruiting at the same time. By this system consecutive bunches of first-class fruit may reasonably be anticipated. The method of detaching suckers

from the parent plant has already been dealt with in this paper, but it may be well to again recommend care in the operation. When digging out suckers it is important that they should be severed completely from the bulb or corm as otherwise they will spring again in a quick space of time which would necessitate the pruning operation being repeated.

Diseases and Pests.—No effective means have yet been discovered whereby the different pests and diseases of bananas in Fiji can be controlled, but it is considered they may be minimised by keeping fields free of all fallen leaves, cut banana stems and any other decaying vegetable matter which might act as harbours. In the case of the scab moth a certain degree of success has been obtained in combating this trouble by dusting the flower of the banana immediately it shoots with Pyrethrum powder and planters should realise that by daily attention to the plants this method of treatment will save at least 75 per cent. of the fruit produced. Another pest, the banana borer, may be trapped in large quantities by cutting up pieces of banana stems and placing them at different intervals around and near to the plant. A tour of inspection should be made every morning to collect the beetles which invariably will be found under the freshly cut stem which is particularly attractive to them.

Harvesting and Marketing of Fruit.—Under favourable conditions the banana fruits in 10 to 12 months from the time of planting. A period of from three to four months is required for the development of the fruit to a stage at which it may be harvested. The proper grade or size of fruit to harvest would all depend on the distance the place of production is from a market and over what period transportation would extend. Assuming that the period is ten days and that six days of that period is utilized in handling and transporting the fruit to a steamer, fruit three-quarters developed should be considered as it not only carries well but is of commercial size and marketable the year round. Fruit matures more rapidly in the moist warm months than during a dry cool spell and if shipments are not frequent, say, once every two weeks there may be considerable loss in the field through fruit becoming overfull, due to a sudden change in weather conditions from cool to warm. In order, therefore, that there be no undue loss through marketable fruit being left on the plants when there is an opportunity to ship, it is highly essential that sound judgment be used in selecting the fruit to cut. Fruit should be cut either the day it is to be packed or not earlier than the previous day. In the operation care should be taken not to bruise the fruit by careless and rough handling which may not show at the time but eventually would when it commences to ripen by going black. Careful handling makes all the difference to satisfactory carriage and subsequent sale of fruit. After being cut it should not be exposed to the direct rays of the sun, otherwise it will scorch or be affected in such a way that it will in a short time become soft and be unfit for the market. An open shed is an ideal shelter prior to packing, but this is not always practicable and dry banana leaves make an excellent substitute. Packing should be undertaken with the same amount of care as would be exercised in harvesting. Placing of fingers in the case which should be absolutely dry and clean is a highly important operation and this should receive the greatest attention. A loosely packed case is as hurtful to the fruit as one packed too tight. If the former method is adopted there is danger of skin disfigurement by rubbing of the fingers through transport vibration whilst the latter through undue pressure is likely to cause bruising. Transport from the field by punt, cutter or lorry of the cases containing fruit to the port of shipment should be done as expeditiously as possible,

but care must be taken that the cargo is not allowed to shift and be knocked about. When by punt or cutter which usually involves a long and sometimes tedious journey, good ventilation is necessary and to avoid cooking or excessive heating of the fruit sufficient air space by dunnaging between the rows of cases should be allowed. Protection against sun and rain must also be considered and an awning should always be in readiness should such be required. Loading on to the steamer is undertaken by the shipping company, and shippers should make it a point to see that the fruit is not roughly handled on the wharf and that it is conveyed to the vessel's hold in a careful manner.

Mr. MacDonald.—From my observations I conclude that the beetle introduced by Mr. Jepson is effectively controlling the weevil borer in some districts.

Mr. Faddy.—Some years ago we could not get a stand and I have planted a field five times. That was before the Jepson beetle arrived. Then we planted an area with 500 bananas and there was no trouble to get 100 per cent. established.

Conference adjourned at 3.50 p.m. until 10 a.m. on the 18th January, 1930.

Conference resumed at 10 a.m. on Saturday, 18th January, 1930.

His Excellency the Governor.—*The first paper to be read this morning is by Mr. Surridge, on the subject of Green Manuring.*

GREEN MANURING.

By H. R. SURRIDGE, A.R.C.Sc., (I), Agronomist, Coconut Committee.

Introductory.—The object of this paper is to attract and stimulate interest amongst the various planters in these islands, in the very sound and inexpensive agricultural practice of green manuring. For this purpose the subject has been treated simply, so that planters who are interested and wish to know more of the matter may obtain further knowledge and help, first on application to their Department of Agriculture in Suva, and where interest is exceptionally keen, by a study of various books, e.g., *Halls Fertilisers and Manures*, de Sorney's *Green Manures and Manuring in the Tropics*, *The Tropical Agriculturist* Vol. LXXIII No. 3, Sept., 1929, and others. That the practice advocated in this paper is essential is demonstrated by the world-wide scarcity of farm yard manure and the need for satisfying the soil's demand for humus, and by the necessity for the application of more intensive methods of agriculture, particularly in those countries where land is restricted in quantity owing either to density of population or difficulties of transport.

Historical.—In the history of agricultural practice, green manuring has long held a prominent place, something of its value having been known to the Romans 2,000 years ago, and to the Chinese over 3,000 years ago, but it is only in recent years that a truer appreciation of its uses and value have come to be known. The Romans noted that when corn succeeded their bean crop a much better yield resulted. The result of this observation was the regular inclusion of beans in their system of crop rotation. This practice became common throughout the greater part of Central Europe and eventually extended to England, but its value was not appreciated there until the 17th–18th Centuries. Agriculture in England up to the

early part of the 17th Century had made very little progress, but with the increasing importance of the wool industry, the changing dietary from fish to meat, of an increasing population, and the introduction from Europe of new types of farm crops, a more intensive system of agriculture was evolved, involving the more active use of green manures.

Up to about 1700 the usual crop rotation was wheat, oats or barley and fallow, but Lord Townsend about this time endeavoured to grow, on his farm in Norfolk, turnips introduced from Belgium and Holland, and, after considerable difficulty, succeeded about 1725 in growing this root crop, thus adding one more crop to the farmer's rotation. But the fallow was still included in that rotation until experimentation demonstrated that with the introduction of another green manure crop (red clover in this case) not only could the new root crop be successfully grown, but owing to the soil rejuvenating qualities of the clover and bean crops, it was possible to dispense entirely with the fallow. This proved a most important innovation for the farmer because, first, it rendered all his land productive all the time, and second, that through this intensive cultivation he was able the more effectively to carry his live stock on through the winter with the additional feed obtained and thus cater for the increasing demand for meat and farm products. It was not until the 19th Century that investigation revealed how bean, clover or pea crops benefited the soil. Experiments carried out at Rothamsted about the middle of the 19th Century demonstrated that the nitrogen content of a soil was increased after a crop of bean or peas, irrespective of whether the bean or pea crop was harvested or not, it being the general custom to harvest the haulm and plough in the stubble. Subsequent experiments proved that if the haulm also was ploughed in, there was a still further increase in the nitrogen content of the soil. It was further found that this property was peculiar to plants belonging to the botanical order of the Leguminosae, with the result that since nitrogen is the most essential ingredient of plant food, as well as the most expensive of fertilisers to purchase, plants of this order have obtained precedence over other plants as green manuring crops.

Definition and uses.—Green manuring is the process of ploughing in various types of farm crops for the purpose of maintaining and increasing soil fertility. When considering green manuring three other important uses may be mentioned—

- (1) as cover crops, to keep down weeding;
- (2) for soil protection against erosion, particularly on undulating land and hill sides;
- (3) as insect pest controls.

Humus.—Other possible uses will occur to the practical farmer to his ultimate benefit. Dealing first with the main purpose of increasing soil fertility, it is of interest to know something of how this is accomplished. One of the most important constituents of a fertile soil is humus. A lack of humus is invariably the sign of a poor soil. Humus is decaying organic and vegetable matter, and functions chiefly by—

- (1) maintaining and increasing soil moisture;
- (2) forming, in its decomposition, humic acid, which interacts with various soil materials, thereby releasing plant foodstuffs;
- (3) supplying foodstuffs for various beneficial soil organisms, which in turn, assist in increasing the supply of plant foods in the soil;
- (4) assisting in aerating the soil.

Leguminous Plants.—In closely-settled countries, up to recent times, farmyard manure was the main source of supply of humus, but with the

advent of the motor, this, the best of all manures, is not obtainable in sufficient quantity; especially is this so in the tropics, with the result that other sources of humus have had to be explored. The continual application of mineral manures without a sufficiency of humus, impoverishes the soil, so that circumstances have compelled the farmer to consider green manuring for its humus, as well as other elements of plant food that are required. In leguminous plants he found a substitute giving him a good supply of humus, and an appreciable amount of that most expensive and necessary of plant foods, nitrogen. An examination of the roots of these plants shows that they have a large number of nodules adhering. These nodules are colonies of bacteria which have the power of assimilating atmospheric nitrogen, and passing it on to the plant in a form which the plant can use for its own growth, and it is the result of this working together between the legume and the bacteria that ultimately results in an increased amount of nitrogen in the soil, whether the crop is ploughed in or not, in a form readily available to the succeeding crop. Experiment has demonstrated that more benefit results to the soil and the standing or succeeding crop when the leguminous crop is ploughed in just about flowering time, rather than running it on to seed.

Use as Green Manures.—Here in Fiji we have continually before us the advantage of green manuring on systematic lines, in the sugar-cane areas of the Colonial Sugar Refining Company Limited. This Company, by the application of green manuring, have not only maintained the fertility of their estates over a great number of years, but have in most instances increased that fertility, and, in other cases, turned and are turning the arid red lands, met with in some parts of these islands, into cane-growing areas through the systematic use of leguminous crops for green manuring. With such a practical demonstration of the benefit of green manuring before one, one wonders why the practice is not more general amongst the planters of these islands.

Coconut Plantations.—The copra industry, at present, is depressed, and there does not appear to be much hope for any marked increase in the market price of this commodity for some time to come, with the result that the producer must consider ways and means of reducing his costs and increasing his production per acre to counteract the loss of income produced by low prices. One method of assisting in attaining this desirable object, is to practice the art of green manuring on the plantations. It is reasonable to assume that the coconut will respond, as other farm crops do, to better feeding and cultivation, within limits. Being slow in its growth, in coming into bearing, and in maturing its foliage and fruit, suggests that a steady supply of plant food is essential for the proper development of the tree and its fruit. For this reason, the application of quick acting manures like nitrate of soda or sulphate of ammonia cannot be recommended, apart from their expense, rather the slow acting and cheap green manure, as supplied by a leguminous crop, seems to answer the necessary requirements. Compared with the artificial fertilisers just mentioned, green manures are slow in their action, and in their decomposition maintain a steady supply of the essential plant foods, nitrogen, of course, being the most important. Add to this the very efficient control such crops have over weeds, the additional humus when ploughed in, thus increasing the moisture content of the soil, particularly during dry spells—an important factor in maintaining an adequate food supply for the tree—and the result should be a reduction in weeding costs on the estate, a cheaper manure bill, the maintenance and probable enhancement of the soil fertility, and an improvement in the general health of the trees so that the yield should be increased.

Coconut Estate Practice.—Present day practice on coconut estates in these islands consists roughly of three kinds—

- (1) neglect (mainly native plantations);
- (2) weeded, either by hand or plough;
- (3) the running of cattle under the trees in other words, these plantations are nominally under grass.

In the case of No. (1) this matter is being dealt with by the Coconut Inspectors who are instructing and encouraging the native to tend his copra plantation with method and intelligence.

Under No. (2) this practice has little to commend it. The ploughing in of weeds gives little, if anything, more than humus and it is extremely doubtful whether this practice pays for the labour involved.

With reference to No. (3) effective weed control is seldom established by cattle, as shown by the presence of lantana, "Koster's Curse," guava, &c., in many plantations running cattle amongst the trees, and it has yet to be proved that coconuts thrive to the best advantage when the ground is covered with grass.

In fruit orchards it is an established fact that in the presence of grass the trees are not so vigorous, the fruit smaller in size and of poorer quality though richer in colour than similar trees in a cultivated orchard. The two chief reasons for this are thought to be (1) presence of excess of carbonic acid gas in the soil, and (2) nitrogen starvation.

Dealing with (1), grass usually forms a dense covering of matted roots which prevent free circulation of air and water. These roots are continually exuding carbonic acid gas, a gas which, being heavier than air, gradually percolates down to the roots of the trees, inhibiting them in their function.

In the case of (2), it is known that the nitrates in the soil occur within the top few inches, so that as this is produced either by rain or bacteria so the grass secures first claim on this important plant food, to the loss of the trees under which it is growing, hence a type of nitrogen starvation for the tree occurs. Such conditions apply to fruit plantations and it is to be expected that similar conditions operate in coconut plantations.

Effect of Leguminous Plants on Soil.—The effect of growing a leguminous crop is opposite to that of grass. Legumes ameliorate the soil by their root action, aerating it, making it much freer for working, and as already mentioned, increase the nitrogen content of the soil, so that the coconut tree stands to receive not only those nitrates naturally formed in the soil, or obtained from the air through the rain, but also those obtained and stored in the soil by the use of the leguminous crop. The result then should be to the advantage of the coconut, a result which planters in the Dutch East Indies, the Philippines and Malaya experience.

Soils.—As regards soils suitable for these green manuring crops, it may be generally stated that all coconut soils will produce leguminous crops. Undrained land does not favour the legume, neither does it favour coconuts, and sour land refuses to grow such crops until the acidity is corrected, the acidity restricting and destroying the activity of the essential bacteria, but application of lime, whether as lime or coral sand, or coral, will rectify this and enable such land to produce good leguminous crops. In these islands coral sand is generally obtainable at little expense.

Time for Ploughing in of Green Crops.—The time for cutting a green manure requires consideration. It is essential that the ground should be covered, particularly during the dry spell, so that if the legume is sown just before the wet season, it should, if an annual, mature towards the end of that season, allowing for some seed to be harvested, and some to be

ploughed in with the haulm to secure a volunteer crop to cover the ground during the dry spell. At the same time, it must be remembered that the maximum nitrogen content in such a crop occurs, as already mentioned, just about flowering time, so that local conditions of seed, manure and other requirements will control when the crop should be ploughed in.

Type of Legume Suitable.—The type of legume here considered is the herbaceous annual, e.g., mauritius bean (*Stizilobium aterrimum*), rice bean (*Phaseolus calcaratus*) or cowpea (*Vigna*), these being the green manuring crops with which planters in Fiji are most familiar, particularly in and near the sugar-producing areas. The advantages of this type of legume are: (a) its manipulation requires the minimum of man power; (b) it covers the ground and controls the weeds rapidly; (c) it furnished supplies of food for man and beast if required; and (d) it produces on the average about five tons of green manure per acre with a fair supply of nitrogen. Where circumstances permit, an application of either coral sand or a combination of a phosphatic and potassic fertiliser would considerably enhance the value of the green manure.

Clover Sickness.—The bush type of legume, however, does not appear to be suitable for our local conditions; first, because hand labour is required to undertake the periodical prunings or loppings of these bushes, and second, because of the difficulty involved when it becomes necessary to eventually plough in this crop, since the stools of these bushes become very woody towards the end of their first season's growth. Such crops, being perennial in habit, would occupy the ground continuously for several years and by so doing, bring about that soil condition popularly known as "clover sickness." In the case of the herbaceous legume such a condition need not arise if two annual legumes are used on the plantation, for the changing of such legumes periodically, each occupying the other's ground, after say two or three volunteer crops have been ploughed in, would tend to prevent "clover sickness."

Varieties of Legumes Suitable.—I am indebted to the *Tropical Agriculturist*, Vol. LXXIII, No. 3, Sept., 1929, for a summary of those legumes in use in Ceylon, Malaya, the Philippines and Dutch East Indies, and below I give extracts of descriptions of those legumes which appear to be suitable for the conditions obtaining here in Fiji.

1. Peanut or Groundnut (*Arachis hypogæa*). Very useful as a green manure owing to its rapid growth. Suitable in dry districts. Good fodder. Not recommended as a catch crop owing to its attraction for rats.
2. Cowpeas (*Vigna catiang* or *V. sinensis*). Suitable for young and old plantations. Is a quick growing annual, forms excellent cover in 3-5 months, thrives on poor land and withstands drought and shade.
3. Mauritius bean (*Stizilobium atterimum*, *mucuna spp.*) Suitable for young and mature plantations and light shade. Is quick growing and when mixed with cowpea in proportion of 1 of cowpea to 4 of mauritius bean, a very quick and efficient ground cover is obtained.
4. Rice bean (*Phaseolus calcaratus*). An excellent bean, withstanding shade. Slow in getting away, but mixed with some cowpea the ground is quickly covered.

It would be necessary to experiment with the others mentioned in the list but not quoted here to observe their behaviour and suitability under the conditions prevailing in Fiji. Of those quoted, three as previously men-

tioned, are already in use on sugar estates and seed can, no doubt, be obtained by those planters who wish to do so, without difficulty.

To summarise, green manuring is an old established agricultural practice which has been proved to be of great value to many crops in many countries under varying conditions. For the coconut planter it offers a means whereby copra production can be increased at a very small expense, an expense which is offset by the saving of labour required for weeding. It furnishes a steady supply of humus, and an appreciable amount of nitrogenous plant food, thereby increasing the water-holding capacity of the soil and supplying a fair proportion of the most expensive of essential plant foods, nitrogen. Its practice has been shown to benefit plantations in Ceylon, the Philippines, Malaya and Dutch East Indies, and it is reasonable to expect that a like result will accrue here in Fiji if planters will adopt the use of legumes as green manuring crops.

Finally, while this paper has dealt more particularly with green manuring as applied to the coconut plantations, a similar result would be obtained if the practice was extended to other tropical crops, whether annual or perennial in character, e.g., bananas, pawpaw, potatoes, &c.

His Excellency the Governor.—I congratulate Mr. Surridge on his paper. I have listened with the greatest interest to it. Green manuring is a subject with which I have had limited experience. Mr. Stockdale, who is now Agricultural Adviser at the Colonial Office, preached the doctrine of green manuring in Ceylon. It is a matter which has been closely gone into by the farmers in Ceylon particularly on tea, rubber and coconut plantations. Mr. Surridge has not dealt in detail with the valuable use of cover crops to prevent soil erosion. In Ceylon, where the hills run to 7,000 feet high, tea is planted on steep slopes and the humus is being washed down into the rivers and low country. I think this is a problem we will have to study in Fiji. My knowledge of the country is not very extensive at the present time, but we have heavy tropical rain and unless steps are taken by way of cover crops and terracing to prevent the soil getting washed away we shall find ourselves in a very precarious position.

Mr. Duncan.—I am doubtful as to the advisability of planting leguminous crops indiscriminately among the coconuts. In my experience it is preferable to run stock in the plantations, by which means the ground can be kept satisfactorily clean. A dense mass of vegetation, even if it were leguminous, would make it difficult to collect nuts and would preclude the grazing of cattle amongst the trees.

Mr. Surridge.—The main object of my paper is green manuring. The question as to whether any particular legume is beneficial for stock food would have to be gone into. There are two considerations, namely, the effect of the legume on the quality of the milk and also on the quality of the meat.

His Excellency the Governor.—With regard to cattle running on a coconut plantation, I know one of the largest planters in Ceylon whose plantation is one of the best I have seen. He is very particular about keeping down the noxious weeds and his cattle are a very valuable asset to him. I do not know whether it is the practice in Fiji to run cattle on coconut plantations.

Mr. Surridge.—With regard to the running of cattle on coconut plantations, I do not think that any progressive planter would be simply content to run cattle without making an effort to keep the noxious weeds, such as "Koster's Curse," Lantana and other pests down.

Mr. Barnes.—An important point in regard to use of leguminous plants in crop rotations, whereby the pernicious system of shifting cultivation,

so largely practised by natives in many parts of the world could be obviated, was not mentioned by Mr. Surridge. In Nigeria, East Africa and in parts of Fiji the native cultivator grows crops on a patch of land until yields fall off owing to the exhaustion of the soil. He then moves to another patch which he clears, plants and deserts in the same manner. These patches of deserted cultivation become rapidly covered with secondary bush and provide a splendid home for noxious weeds, thus becoming a source of infection for the areas around them. In Nigeria the Department of Agriculture has for some years experimented with systems of crop rotations, including the use of leguminous crops, to enable the natives to keep the same area of land in cultivation year after year. Such work is necessary here in Fiji, and Mr. Surridge's observations on the conditions of green manuring apply perfectly to the improvement of native systems of agriculture. In the issue of the *Agricultural Journal* for the last quarter of 1929 reference was made to an address of Mr. Stockdale, Agricultural Adviser at the Colonial Office, on the subject of soil erosion. This is a matter of vital importance to Fiji. We have excellent examples of the results of soil erosion in our river flats which consist entirely of soil eroded from the higher lands and brought down and deposited in the flats by the streams. Valuable as these river flats are, it must be borne in mind that the hillsides from which they have been derived have been denuded of soil and their capability of supporting vegetation thereby reduced. Examples of the wrong system of cultivating slopes are with us in Fiji. It is quite improper to plant on such land in the direction of the slope as soil erosion is thereby encouraged. Sloping land should be cultivated and planted parallel to the contour lines, that is at right angles to the line of the slope at any point, in order ultimately to secure a terraced effect, thus checking the washing away of the valuable surface soil. Here again the practice of green manuring is a valuable asset as surface washing can be largely checked if the ground is kept covered.

His Excellency the Governor.—I now ask Mr. Tarby to read a paper on Indian Agriculture in Fiji.

INDIAN AGRICULTURISTS' CONTRIBUTION TO THE AGRICULTURAL PRODUCTION OF THE COLONY.

By J. P. TARBY, Manager, Government Rice Mill.

IN respect to agriculture, Fiji may well boast of many assets and natural resources such as mild climate, dry and wet zones, fertile soils and abundant water-ways, &c. Perhaps, however, the foremost asset is the Indian agriculturists and their co-producers, the Indian labourers. Indeed, since it may now be assumed without fear of contradiction that the great majority of the present Indian population has made Fiji their permanent home and that their progeny can be counted upon also to remain here, the Indians may be likened to one of Fiji's natural resources. But, like all natural resources, unless utilised, they are, in respect to agriculture, of little economic importance, and unless properly and discreetly utilised, they cannot yield of their best. This is a maxim that should be applied to the Indian agriculturists and their co-workers, the Indian labourers. Conversely, as no natural resource can yield its worth or wealth of its own accord, that is, without organisation, direction and the outlay of some capital to exploit it, the Indian agriculturists cannot, more especially if expected to produce

in various directions, produce of their own initiative, that is, without tuition, direction and assistance (not necessarily in money) for their utilisation. This is another maxim that should be applied to the Indian agriculturists and their co-producers in Fiji. Strange to say the comparison of the Indian agricultural community to a natural resource has greater truth in it than at first meets the eye. Compare them for example, to the newly formed auriferous sandy deposits to be found in various parts of the world. Valuable, but hopelessly disunited, except by a common temporarily binding, but weak agency—water in the case of the sandy deposits and nationality in that of the Indian agricultural community. The time will come when the Indian agricultural community will be bound into a whole by firm and lasting agencies, but pending that time, which can only be reached by the slow process of tuition, co-operation and organisation, artificial means (European leadership and control) must be applied if greater production in agriculture is to be sought among them, more particularly among the agriculturists outside the sugar industry.

These three main points should be borne well in mind, and acted on, if the Indian agricultural community is expected to contribute in a fair measure to the agricultural production of the Colony. As colonists, and in fairness to themselves and to their adopted country, they should, and would, if the above maxims were more generally applied. When expounding these views to a European elected member lately he opposed them on the ground that it would be pampering the Indians. What fallacy! More especially when it is considered that the Indian is here for the advancement of production rather than for social reasons. Moreover, can any means wisely applied in the direction of production or greater production, be it to a human being, a horse, or a piece of machinery, be misconstrued into pamperism? For answer I direct any doubting person to the Colonial Sugar Refining Company, their treatment (pamperism?) of the Indians, and their success and profits. The necessity for the application of these main points becomes all the more evident when it is considered that due to lack of organisation and co-operation among themselves, their inborn propensity for false economy and their lack of business knowledge from a broad point of view, the Indian agriculturists and their helpers, when and wherever acting on their own initiative, that is, away from European leadership and control, find themselves at a great disadvantage in that there is no co-operative ownership of implements, live and transport stocks, nor can they perform certain essential works on co-operative lines, nor do they know what to grow, how best to grow it and how and where to dispose of it to the best advantage. This estrangement from European leadership and control leads also to a desire to live a purely village life, that is, to produce very little more of their own staple food than is needed to exist on, and, practically nothing else.

The ascertainment of the exact production by the Indian agriculturists, which includes a few indispensable Indian wage-earners, is not easily arrived at for the reason that the agricultural statistics of the Colony are unreliable, if not misleading, but a fair estimate of their production can be formed by round about means. For this purpose, I have prepared certain tables based on imports, exports and estimates which, I think, go a long way towards exhibiting the relation of the Indian agricultural community to the agricultural production of the Colony. Due allowance will have to be made for the figures based on estimates, but I venture the opinion that while the itemised figures may differ, the aggregate of the estimated production is not far out one way or the other. At any rate, it is only by large

omissions and commissions in those estimates that the *per capita* production can be materially affected. I do not, however, see where they can arise. The net result of these tables point to four important facts, viz.—

- (1) that the average *per capita* production by the Indian agricultural community is not nearly as high as it should be;
- (2) that the *per capita* production by the cane-growing Indian community is 157 per cent. more than the *per capita* production by the Indian agricultural community outside the cane-growing areas;
- (3) that the production by the Indian agricultural community outside the cane industry, is not only very low but that it is on the decline;
- (4) that the Indian agricultural community when not under the leadership and control of Europeans, ceases, practically, to be of economic importance in respect to agriculture.

Dealing with the main points of the tables, (see appendix), the following is to be gleaned:—

Imports, 1923-28.—(a) The average (£1,455,090) of total imports into the Colony has increased in value by 25 per cent. since 1923.

(b) The importation of Indian foodstuffs (rice, sharps, dhal, mustard oil, ghee, spices, potatoes and onions) has increased (in aggregate value) by about 33 per cent. since 1923.

Exports, 1923-28.—(c) The average value (£1,870,259) of total exports of the Colony has increased by 28 per cent. since 1923.

(d) The average value (£60,299) of exports of products with which Indians, as labourers only, are hardly connected, shows decrease in some products and increase in others.

(e) The average value (£1,148,339) of export of products (sugar, molasses and rubber) with which Indians, (as labourers and mostly as growers) are largely connected, but under leadership, control and organisation of Europeans, has increased 63 per cent and 69½ per cent. for sugar and molasses respectively, and decreased 45·83 per cent. (£3,900) for rubber.

(f) The average values (£14,067) of export of products produced and controlled entirely by Indians, with slight assistance (manufacturing, shipping and sales) from Europeans, have decreased as follows:—Cotton, 50 per cent.; cotton seed, 59·44 per cent.; pineapples (fresh), 21·94 per cent.; and maize, 100 per cent.

(g) The average ratio (in group values) of average values of imports and exports as in (a), (c), (d), (e), and (f) enumerated above to the total average values of imports and exports works out as follows:—

		<i>Per cent.</i>	£
Imports—(a)	.. ..	7·24	89,896
Exports—(c)	.. ..	3·22	60,299
„ (d)	.. ..	34·81	651,090
„ (e)	.. ..	61·40	1,148,339
„ (f)	.. ..	0·75	14,067

(h) The total estimated average value of the locally grown and consumed products (rice, dhal, maize, pineapples, spices, tobacco, mauritius beans, milk, ghee and vegetables) over and above the values (£14,067) of such products exported, produced by Indians outside the cane-growing areas, amounts to £129,104.

(i) The estimated average value (£129,104) of products grown and consumed locally, treated as exports and added to the average value of total average exports (£1,870,259) increases the average value of total average

exports to £1,999,363. On this basis the percentages and values given in (g) now are:—

Imports—(a)	..	..	..	Not affected.
Exports—(c)	..	..	3.02%	60,299
„ (d)	..	..	32.56%	651,090
„ (e)	..	..	57.45%	1,148,339
„ (f)	..	..	7.15%	143,171

(j) The total number of Indians estimated to be engaged in agriculture including 2,500 co-workers, is 20,750 (adult males) and their yearly *per capita* average production is £39 18s. 2d. While their distribution is:—Sugar industry, 13,750; Other industries (outside cane industry), 7,000; total, 20,750.

(k) The estimated *per capita* yearly production of the 13,750 Indians directly and indirectly engaged in the sugar industry is £52 11s. 0d., and that of the 7,000 Indians engaged in industries other than the sugar industry is £20 9s. 0d., leaving an increased *per capita* balance in favour of Indians under European control of 157 per cent. or £32 2s. 0d. per annum.

(l) The estimated Indian population at 31/12/29 is 71,000 and the occupational distribution of the population is estimated to be:—

directly and indirectly engaged in and dependent on the sugar industry, 15,000 adult males, or with women and children, 51.38 per cent. of the population;

engaged in agricultural industries, other than those of sugar, rubber, coconuts, bananas and vegetables, 7,000 adult males, or with women and children, 24.0 per cent. of the population; and

engaged in commercial, domestic, &c., enterprises and as labourers in rubber, coconut and banana industries, 7,212 adult males, or with women and children, 24.68 per cent. of the population.

Much more information could be given but I think sufficient evidence has been produced to warrant the verdict that greater production could be attained by the Indian agricultural community than has been shown, more particularly by the members of the community engaged in industries other than that of sugar. Based on the *per capita* production of those engaged in the sugar industry, the Indians outside this industry could increase their present *per capita* production by 157 per cent. that is, they could produce most of if not all the Indian foodstuff now imported (about £90,000 worth) besides providing all the rice needed for local consumption (10,000 tons) and some 500 tons more for export. Further they could produce 2,000 bales of cotton, 300 or more tons of maize, 100 tons of mauritius beans and 300 or more tons of pineapples (fresh) for export, as well as quantities of sesame, cotton seed and groundnut for the manufacture of margarine, locally, to take the place of ghee and for export, also coriander seed and linseed for export, besides many thousands of tons of pineapples for canning purposes. Regarding the Indians engaged in the sugar industry, their *per capita* production, though very fair, should be increased by the growing of rice for home consumption. For reasons to be adduced later, every man on the land, regardless of the industry he is engaged in, should be made to grow sufficient rice to provide for himself and his family.

While it is possible to increase the agricultural production of the Indian community outside the sugar industry from the present average production of £129,104 to from £300,000 to £350,000, very little improvement on the present production can be looked for unless two or more European Inspectors with an Indian staff are appointed to do all things possible to further production. The material is at hand, but needs to be moulded into shape. This

may mean much endurance and take time, but the goal is well worthy of an attempt. Chair-legislation in regard to agriculture among the Indians has ruled for many years with the poor result evidenced; let us now, I say, be up and doing for the betterment of the Indian agricultural community and for that of the Colony in the way of greater production. In the event of a desire to improve the present agricultural conditions among a certain class of the Indian agricultural community, and with the view of facilitating and expediting the carrying out of this desire, I have prepared, for Departmental use only, a set of papers giving a short local history of each product now grown by Indians, with suggestions for the growing of new ones, and making tentative recommendations for the improved and greater production of each. To assist further I would venture a general recommendation to concentrate without delay on greater production of Indian foodstuffs and on the extension of the cotton industry and the possibilities of the greater expansion of the pineapple industry to meet contingencies in the event of a set-back to the sugar industry arising from the combined effect of the total or partial removal of the preferential tariff and the low price of sugar throughout the world. Other sugar-producing countries are being sorely tried by the depressed state of the sugar market due to overproduction. Should it be found necessary to reduce the price of cane here by the removal of the bonus of three shillings per ton of cane (equal to 24 per cent or £12 on the present *per capita* production) the Indian cane-growing community would be appreciably impoverished, but should greater curtailment in the price and a reduction in the production of cane have to be made, then the large proportion of the Indian population dependent on the sugar industry would be in a very sad plight indeed unless there was sufficiency of cheap food and certain other commercial agricultural industries they could take up, to relieve the depression.

See inserted Tables.

His Excellency the Governor.—I thank Mr. Tarby for his interesting paper which indicates very careful research. The enterprise of our Indian population compares favourably with that shown in other parts of the world, but, of course, it is obvious that there is much more scope for the Indians in agriculture, and it is our object as far as we possibly can through the Agricultural Department to assist them to grow proper crops and to grow more crops. I hope the Indians present to-day will join us in the discussion and give us any information which may be of use regarding their needs.

Mr. Grant.—The trouble amongst the Indian agriculturists is finance. The Colonial Sugar Refining Company have a good system. A man might have five acres of land which he wants to plant. He works very hard and two or three acres are planted and he then finds that he cannot plant any more. I think the Government should consider the establishment of an Agricultural Bank in the same way as is done in India and if this was done it would help things along very nicely. Of course, there are money-lenders, but they want such a high rate of interest.

Mr. Turbet.—I agree with the remarks made by Mr. Grant. The Colonial Sugar Refining Company advance money to their tenants and when the crop is crushed the advances are repaid and the Indian cultivator is still left with a surplus. I think Mr. Tarby said that Indians working under that Company received £51 per annum while those working on their own only received about £20. If some means could be devised whereby

the Indians were assisted financially I think they would make a bigger return.

Mr. Grant.—With reference to the Indians working for the Colonial Sugar Refining Company they have no trouble about the cutting of their crops. They supply the labour and also pay wages. In districts like Navua for instance, all the crops are ready together and an Indian finds it difficult to get labour to help him harvest his crop.

His Excellency the Governor.—*I thank you for your valuable contribution to this discussion. I am quite in agreement with your ideas. The matter is one of some difficulty and I would welcome any considered suggestions from the Indian community as to how we should go about it. I will ask Mr. Barnes whether he can devise some means which will enable the Indians to work in co-operation with the Agricultural Department.*

Mr. Grant.—Some time ago six Indian lads went to India to study agriculture. They have now returned to Suva and I think it would be a good thing for Mr. Barnes to see them. I would like to see it made possible for some more Indians lads to be trained in agriculture.

Mr. Barnes.—I am very much obliged for the valuable suggestion. I shall be glad to meet those interested in agriculture. Several of your community have already visited me. I can assure you that I shall be most happy to interview any of your people at any time provided they make arrangements to see me.

Mr. Vishnu Deo.—I do not agree with Mr. Tarby's statement about Indians requiring European leadership. I think it is always better for Indian farmers to be settled on the land under nobody's control. I consider that they should be given financial assistance to enable them to get on the land. It would be better if an Agricultural Bank was established. But money is not the only trouble that Indians have to face. Sometimes they cannot get the land. They make an application and this is submitted through the usual channels and then it is turned down because the natives will not surrender the lease. Then there is the question of transport facilities which in most country districts are very poor because of the lack of roads. Produce has to be carted by bullock wagons and across rivers, and this is very expensive.

His Excellency the Governor.—*This discussion is of the greatest interest to me. With regard to the leasing of land I can assure you that the question of a better system of land tenure is receiving attention and I am forwarding proposals to the Secretary of State. With regard to transport I consider that this question is entirely wrapped up in the question of the prosperity of this Colony. I hope that before long we shall have a road running direct to Sigatoka. There is also the question of subsidising small vessels to run regular trips between the various islands. I am pleased to inform you that the Secretary of State is enquiring as to the possibility of transport by seaplane between the various islands. I think this is a vital matter and I consider that an improvement in transport facilities will be of the greatest assistance to the Indian community, and indeed to the whole Colony.*

Mr. Grant.—Thank you very much, Sir, for your remarks. I can assure you that we all want to co-operate with you in advancing the prosperity of the Colony.

Mr. Barnes.—I think the discussion might conveniently be closed by my summarising the important points which have been raised. The whole theme is one of organisation of Indian agriculturists. The Colonial Sugar Refining Company is, in fact, an agricultural organisation which includes provision for the points raised by Mr. Grant. Financial assistance is an

important matter in connection with their organisation. The discussion has brought out the fact that some scheme for financial and instructional assistance to Indian agriculturists is necessary and His Excellency has instructed me to prepare such a scheme for his consideration. Mr. Tarby in expressing his views has called attention to the comparatively poor returns made by Indians outside European agricultural organisations. Mr. Grant and Mr. Vishnu Deo have pointed out that the whole trouble is lack of finance—lack of capital. These difficulties have been overcome in other countries and there is no reason why they should not be overcome here. Co-operation is essential. The important points brought out in the discussion will stimulate the Agricultural Department to inquire into these vital matters.

His Excellency the Governor.—I now declare this Conference closed. I wish in the first place to congratulate Mr. Barnes on the success of this first meeting and I wish also to express my appreciation of the part taken by all members of the Department. I am always talking about education. I think education is of vital importance, but it does not merely mean the teaching of the “three R’s.” The first thing is to find efficient teachers, and in the staff of the Department of Agriculture I am satisfied that we have excellent men to teach the community. I might state that Mr. Barnes has suggested that future Conferences could be arranged at the time the Agricultural Show is being held, which is usually in October. I think this is an excellent idea. I hope that members of the public will contribute Papers on their own account. It would be most interesting for us to have the experience of practical men on agricultural questions.

FIJI LIVESTOCK RECORD ASSOCIATION.

MINUTES OF MEETING OF BOARD OF DIRECTORS HELD ON JANUARY 16, 1930.

The following were present:—Superintendent of Agriculture, (Chairman), Senior Veterinary Officer, G. Kiss, Esquire, and J. Barber, Esquire.

The minutes of the last meeting of the Board were read and confirmed.

Position on Animal of Association Brand.—At a meeting of the Board held on the 24th October, 1929, the Board directed:—

“That owners of stock should be permitted to brand registered animals on such conspicuous parts of the body as they should desire.”

After discussion the Board decided that, in conformity with the provisions of the Brands Ordinance, the Association's brand should be placed on the near neck or on either cheek, the earlier direction being repealed.

Annual Report.—The Board approved of the Report which has been prepared for submission to the Annual General Meeting of the Association.

Date of next Meeting.—The Board directed that the next meeting should be held on the 10th April, 1930.

MINUTES OF ANNUAL GENERAL MEETING HELD ON THE 16TH JANUARY, 1930.

The following were present:—Superintendent of Agriculture, (Chairman). Messrs C. R. Turbet, H.M. Stuchbery, J. Barber, G. Kiss, L. N. Bean, A. Barker and G. D. Hill.

The minutes of a special general meeting held on the 15th October, 1929, were read and confirmed.

Annual Report and Financial Statement.—The Honorary Secretary read the Annual Report and financial statement which were adopted on the motion of Mr. Barker, seconded by Mr. H. M. Stuchbery.

Appointment of Honorary Auditor.—On the motion of Mr. Barker, seconded by Mr. Hill, the meeting directed that Mr. P. J. A. Hamilton be requested to act as Honorary Auditor to the Association.

ANNUAL REPORT FOR THE YEAR 1929.

The Board of Directors of the Association submits the following report in respect of the year 1929.

Members will remember that the inaugural meeting of the Association was held on the 1st September, 1927, that little progress was made and that until October last the Association was, to all intents and purposes, defunct. With a view to reforming the Association the Superintendent of Agriculture, Chairman of the Board, called a meeting on the 15th October last. At that meeting, at which 12 gentlemen were present, it was decided to reform the Association.

Election of Board of Directors.—Under the rules of the Association the Board consists of the Superintendent of Agriculture (Chairman), a Government Veterinary Officer and three elected Directors. The Directors elected at the meeting on the 15th October last were:—Mr. J. Barber, Mr. R. Craig, and Mr. G. Kiss.

The Superintendent of Agriculture appointed Mr. A. B. Ackland to be Honorary Secretary of the Association.

At the Special General Meeting members recommended to the Board of Directors that action be taken to:—

- (a) seek approval for the use of the *Agricultural Journal* as the official organ of the Association;
- (b) amend the Rules of the Association to provide, amongst other things, for reduced membership and registration fees.

As the Association was not re-formed until the middle of October the Board held only one meeting during the year.

The Rules of the Association have been amended on the lines proposed by members and approved by the Board and duly published in the *Royal Gazette*. They are published in the last issue of the *Agricultural Journal* and your Board now await separates for distribution to members.

His Excellency the Governor has been good enough to approve of the use of the *Agricultural Journal* as the official organ of the Association.

The Association's brand has been decided upon and application has been made for the registration thereof.

Your Secretary has addressed some 35 gentlemen in regard to becoming members of the Association. As the amendments to the Rules were not published until the 13th December it was not possible to do much towards the enrolment of members before the end of the year.

Together with the amount carried forward from 1928 the balance at the credit of the Association's Account at the 31st December, 1929 was £7. There were no items of expenditure during the year.

The financial statement placed before you at this meeting has not been audited as the appointment of an Auditor, as provided by the Rules, has not been made. Your Board of Directors recommend that the Auditor, when appointed, should examine the accounts for the year under review.

FIJI LIVESTOCK RECORD ASSOCIATION.

STATEMENT OF ACCOUNT.

<i>Expenditure.</i>		<i>Revenue.</i>	
To Balance carried forward		By Balance brought forward	£4 0 0
to 1930	£7 0 0	By Subscription paid 1929 .	3 0 0
	<u>£7 0 0</u>		<u>£7 0 0</u>

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 3.]

SECOND QUARTER, 1930.

[No. 2.

EDITORIAL.

FIJI SHOW.

Arrangements are well in hand for the Annual Fiji Show to be held in October next. This year it is hoped that the Agricultural and Horticultural Sections will be more truly representative of the Colony's primary industry. Doubtless the Show suffers from the lack of a permanent home, which necessitates a very rapid preparation of the buildings now used and hurried arrangement of many of the exhibits. Even these difficulties can be largely surmounted by closer co-operation between exhibitors and the officials of the Show. Early entries enable the available space to be planned and allocated to the best advantage.

The Department of Agriculture proposes to take a more active part in the Show this year by staging a departmental exhibit which is being prepared under the direction of a committee of senior officers. It is intended to arrange for illustrated lecturettes on important and interesting aspects of local agricultural pursuits. Members of the department will be glad to render any assistance possible to intending exhibitors.

It is felt that the objects of the Show Association are worthy of wider support by the public of Fiji. There can be no doubt that we are all primarily dependent directly or indirectly upon the success with which agricultural pursuits are carried on. The Show offers an opportunity for bringing together examples of the varied plants and crops grown in the Colony, and is important from the social aspect, offering as it does a meeting place under congenial conditions for all those people actively or passively interested in our productions and industries. The Secretary of the Fiji Show Association welcomes inquiries and will be glad to furnish information regarding both membership and participation in the Show.

AGRICULTURAL CONVENTION.

This function, foreshadowed at the Agricultural Conference held in January last under the Presidency of His Excellency the Governor, will be held during the same week as the Show, and will furnish a welcome opportunity for members of the community to discuss important questions concerning local agriculture. Details have not yet been worked out, but it is proposed to select a few of the more urgent questions of the day for consideration, among which will be the noxious weed problem, the present position and prospects of the dairying industry and copra production. The method of treatment will be by discussion, and each discussion will be opened with a short speech by some local gentleman who is intimately familiar with the subject. In order to give opportunities for speaking to as many people as possible, speakers will be asked to intimate their intention of taking part and the duration of speeches will be limited.

NOXIOUS WEEDS.

The recently issued circular and questionnaire on the subject of noxious weed control in Fiji is printed in this Journal. The response to the request for information from practical agriculturists is most gratifying and that so far collected is of great value. The data received is being abstracted and correlated with a view to publication in a later issue of the Journal. The material will be of value as a basis for extended discussion at the Agricultural Convention, and it is hoped that later it will provide a foundation for a determined campaign directed to the reduction of the serious losses to many agricultural pursuits caused by the prevalence and spread of these undesirable plants.

Information from any persons interested in the subject who have not already furnished replies or who may not have received copies of the circular will be welcomed. Additional copies of the circular and questionnaire will be supplied on application to the Superintendent of Agriculture.

GRASS LAND FARMING.

In this issue, an excerpt from an interesting and informative pamphlet, issued by Imperial Chemical Industries on the modern system of pasture control, is published. The importance to the dairying industry of proper pasture cultivation and control cannot be over-emphasised. Scientific research has clearly shown the benefits to be derived from the utilisation of grass at its period of maximum nutrient value, and has pointed the way to the increased production and profits which may be derived by dairymen who adopt this essentially sound and practicable system of pasture management. At the January Conference the limited supply of concentrates available for the stall feeding of cows in Fiji was bewailed. A method of avoiding the necessity for using any concentrates is available and can be adopted with advantage in such a country as this where growth is so luxuriant as to tempt many of our dairymen to leave their pastures until the grass is long and comparatively indigestible before grazing them. The services of officers of the department are placed at the disposal of dairy farmers who require information regarding the establishment and layout of pastures, manures and implements for grass land cultivation. Literature on the subject may be consulted in the Library at the Suva offices.

AGRICULTURAL STATISTICS.

A committee consisting of the Assistant Colonial Secretary, the Acting Secretary for Native Affairs, the Inspector-General of Constabulary and the Superintendent of Agriculture (Chairman) was appointed to consider and report upon the method of collecting agricultural statistics. As a result of the committee's recommendations, it has been decided to alter the method of obtaining returns, to call for returns as on 1st July each year and to use a simplified schedule including only the principal crops. Returns under the new system will be called for shortly in respect of the year 1st July, 1929—30th June, 1930.

COPRA.

In his paper on the "Effect of Mould Action on Copra," Mr. Blackie has called attention to a hitherto little discussed aspect of the various factors which contribute to the deterioration and loss of copra. There is a widely held feeling that improved methods of preparing and handling copra are unlikely to be economically sound; that the small, increased return obtained by placing a better quality of product on the market will be more than

counterbalanced by the increased cost of preparation, and that the producers' interests are more likely to be best satisfied by offering for sale an article of low quality which demands a fairly ready sale rather than by attempting to improve their methods in order to secure the small advance of market price likely to accrue.

Copra preparation is an art which must call science to its aid if it is to succeed in meeting the keen competition of other vegetable oil bearing products. Arguments advanced against improved methods of preparation have in many instances been based on false premises. The few shillings extra per ton obtainable for a better quality have been allowed to obscure the possibilities of putting a greater quantity of the better quality on the market from the same amount of raw material by the adoption of improved processes of preparation.

The serious losses of produce occasioned by mould action was discussed at the recent Imperial Mycological Conference, more particularly in their relation to the cacao industry. It is evident to anyone familiar with the copra industry that similar factors exercise a grave influence on the economics of that industry, and it is clear that research is necessary to measure the losses and to evolve means of minimising them.

Mr. Blackie has discussed the problem in a deeply thoughtful manner. His paper affords a useful basis for further work and indicates a measure of the possible increased returns which may attend methods of preparation of copra directed to the reduction of losses by mould action.

MISSION TO TRINIDAD—INTRODUCTION OF LIOTHRIPS URICHI.

PREFACE.

IN preparing the attached report on my mission to Trinidad to obtain the thrips *Liothrips urichi*, I have commenced with an introduction, containing first a short history of the pest *Clidemia hirta* in Fiji and the early inquiries which led up to the attempt to control it by biological methods, followed by a brief narrative of the present mission. A few details of the life history of *Liothrips urichi* have next been given and of those factors which tend to limit its numbers and efficiency, several additional enemies of this useful insect having been discovered and now recorded for the first time. Following this the natural control of *Clidemia hirta* is discussed at some length, a number of new facts being recorded which throw fresh light upon the agencies which hold this group of plants in check in their natural habitat, leading to conclusions considerably at variance with those hitherto held.

During the course of this work much assistance has been received from the various officers with whom I was brought in contact. Specimens of the various insects recorded herein have been sent to the Imperial Bureau for identification, but at the time of preparation of this report, such identification has not been received.

HISTORY OF THE PLANT CLIDEMIA HIRTA IN FIJI.

The plant *Clidemia hirta* is a member of the natural order *Melostomaceæ*, and is supposed to have been accidentally introduced into Fiji, with coffee plants from British Guiana, some time prior to 1890. It was first noticed growing along certain wire fences in the Waimanu Valley, near Suva, whence it spread into the adjoining paddocks, especially around stumps and bushes. Soon after this it began to assume the proportions of a major

weed, invading the permanent cultivations and native forests. Its spread into the pastures was particularly serious, as it soon greatly reduced their carrying capacity. There is little doubt that it was the presence of the introduced Mynah bird of India, which, feeding upon the berries and haunting cultivated lands and paddocks, led to the phenomenally rapid spread of the plant. As soon as the danger of the new introduction was realised, Knowles, then Superintendent of Agriculture, took steps to have the plant identified and to ascertain its native habitat.

About 1920 correspondence was opened with Jamaica, British Guiana and Trinidad to find out whether any agencies were known to hold the plant in check in those countries. Dry material and drawings of the flowers were also prepared by the writer and forwarded to Trinidad for comparison with the local species, recorded under the same name.

As a result of the attention thus called to it a number of plants of *Clidemia hirta* were dug up and placed in the old experimental station at St. Clair. Whilst thus under observation Mr. F. W. Urich discovered the thrips, which now bears his name, feeding upon the young foliage. He worked out its life history, recording at the same time certain natural enemies tending to hold its numbers in check. These were three in number, and will be dealt with later, together with certain additional ones discovered during the present mission. At the time that Urich made these discoveries no very great value was placed upon the controlling effect of the thrips, and no further action was taken in the matter until 1927, when Mr. T. H. C. Taylor, who was visiting Trinidad in connection with coconut work, made a "preliminary study of the plant with a view to finding some controlling factor, which might be applied to Fiji." (Council Paper, Fiji, No. 14 of 1928.) This officer expressed a favourable opinion as to the value of the thrips and it was decided to investigate the matter further. Through the courtesy of the Principal of the Imperial College of Tropical Agriculture, Colonel Evans, a student (Mr. W. Cook) was detailed to carry out a series of feeding experiments to test whether this insect could be induced to attack any plant of economic importance, which would render it dangerous to introduce it into Fiji. This entomologist's investigations also proving favourable, it was decided to attempt the introduction of the thrips into Fiji and I was instructed to carry out the work. With this object in view I left Suva on 5th September, 1929, travelling *via* Auckland and Panama and arriving at Trinidad on 21st October.

On arrival at Port of Spain, after first calling upon His Excellency the Acting Governor and the Colonial Secretary, I went to the Experimental Station at St. Clair where I called upon the Acting Director of Agriculture, Mr. G. M. Gilbert, who introduced me to the Superintendent of the Botanical Gardens, Mr. O. H. Williams, who subsequently gave me much assistance in my work. Later in the day Mr. F. W. Urich who had made the original discoveries in connection with the thrips called and took me to a place where he was able to show the plant with the thrips at work upon it. Having finished these preliminary matters in town I proceeded to the Imperial College at St. Augustine where it was proposed that I should carry out my work. Here I was very kindly received by Mr. H. A. Ballou, who was acting during the temporary absence of the Principal, Colonel Evans, and a laboratory was placed at my disposal.

VISIT TO BRITISH GUIANA.

As soon as work was commenced it was noticed that there were certain indistinct differences between the Trinidad form of *Clidemia hirta* and that causing so much trouble in Fiji. As the Fijian species was supposed origi-

nally to have come from British Guiana, inquiries were made to see whether the plant was readily obtainable there and the reply being satisfactory, a flying visit was made to Georgetown and a quantity of material obtained from that district.

A thrips similar to the Trinidad species was found to be present in small numbers, but with evidence of being more abundant in the dry season. The general appearance and growth of the plants was more like that to which we are accustomed in Fiji. This may, however, be due to the fact that the heavy wet clay is more akin to the conditions in the latter country than the rocky hills of Trinidad.

COLLECTION AND TRANSPORT OF THE MATERIAL TO FIJI.

Owing to the rocky nature of the soil in those parts of Trinidad where the plant was to be found, considerable difficulty was experienced in obtaining sufficient quantities and establishing them in the tins in reasonable time. Another difficulty was met with in the form of White Fly, which was found on most plants dug up and which in the breeding cages, increased rapidly, causing much loss. Efforts were made, by breeding from adults only, to eliminate the natural enemies of the thrips, but although their numbers were greatly reduced this was not entirely successful, and as with previous importations, careful screening was necessary on arrival.

Seventeen cages, each containing nine tins with growing plants of *Clidemia hirta* were prepared and infected. These were shipped from Trinidad on 8th February, arriving at Colon 12th February, in good condition. At Colon they were railed across to Balboa where they were held in one of the goods sheds until the departure of the "Zealandic" for Suva. This latter was delayed until 23rd February, necessitating ten full days for the plants in the darkness of the shed. This led to considerable destruction of food owing to the numbers of the thrips and the unfavourable growth conditions for the plant. Immediately the ship put to sea these were carefully gone over, cleaned up and many hundreds of thrips and pupæ renewed. The latter were placed into cool storage to check development, a method which had been tested whilst in Trinidad and which proved very successful. In addition to the insects in the breeding cages a large number of young shoots of *Clidemia* with eggs upon them had been collected just prior to sailing; these were placed in water. After much search two strong plants of what appeared to be the same species were found at Ancon. Although differing considerably in general appearance from the Trinidad or Suva form of *Clidemia hirta* it was found that the thrips took quite kindly to these also.

As a result of these combined methods an immense number eggs, nymphs, pupæ and adults of the thrips reached Fiji in good condition. To what extent this introduction will prove successful remains to be seen.

DISTRIBUTION IN FIJI.

In order to prevent the possibility of introducing any undesirable insects with the thrips, adults only were removed from the imported material, by hand, and placed upon leaves from local plants. These leaves were then laid upon growing plants, which were kept covered by a screen. In this way 2,500 adults were released by the 15th March, and a further 900 on the 17th, when it was observed that those liberated on the 15th had commenced to oviposit upon the Fijian plants.

LIOTHIRIPS URICHI, KARNY, AND ITS HOST, CLIDEMIA HIRTA.

The life history of *Liothrips urichi*, Karny, has been worked out, first by Urich and later by Taylor and Cook. The last named gave a very care-

ful description of the various stages, so that no further work on these was felt necessary, the details only being checked over. It was noticed, however, that the description of the egg, as smooth, was incorrect, it being covered with minute hexagonal pustules, which seem to have escaped observation. These pustules were absent from what is presumably the micropilar end.

The following are a few brief notes on the different stages:—

Eggs.—These are generally laid on the under surface of the terminal pair of leaves, or on the adjoining stem; occasionally, however, they were found near the base of the next older pair.

Nymphs.—These feed on the more succulent portions of the plant, either stem or leaves, and sometimes on the flower buds. In this latter case they cause the bud to drop off. They are crimson in colour with two black scutiform plates on the prothorax and two black oblong plates on the eighth segment and the tube. There are only two nymphal stages, both similarly coloured.

Prepupa.—This is also crimson, but those portions which are black in the nymph, are transparent in this stage. It is easily distinguished from the pupa by the absence of wing buds and the free antennæ.

Pupa.—This is also red, but has the antennæ fixed to the sides of the head and has well developed wing buds. Both pupa and prepupa are capable of movement but take no nourishment and are placed on the under-surface of a leaf, generally congregated at the bases. These wilt, dry up and fall to the ground.

Adults.—The adults are shining black with well developed wings. They are to be found in the same situations and associating with the nymphs and pupæ.

NATURE OF DAMAGE INFLICTED UPON THE PLANT.

The insects feed, either as nymphs or adults, by sucking the juices of the plant, which develops a brown spot surrounded by a pale area at the point of attack. The adults also often attack the veins of the young leaves causing them to contract and curl over, so that the head of the attacked plant is generally distorted and has a washed-out appearance. As the terminal foliage is destroyed the nymphs move down the stems, which die back. In the case of young plants this die-back is apt to extend to the roots, which, however, are not injured and normally the plant throws up new growth unless other conditions are unfavourable. The effect of the destruction of the terminals is to give the plant a stunted appearance in those areas where the thrips is abundant, as compared to where it is absent. In the wet season, however, the attacks are less severe and the plant makes rapid growth, producing quantities of flower, and it seems probable that were it not for the destruction of these by agencies, to be mentioned further on, the effect of the thrips in preventing the spread of the plant would not be very great.

In the breeding cages it was observed that, as the terminal shoots died back, the adults did not oviposit upon older leaves, but left the plant, flying freely and crowding upon the calico sides of the cages. It was also noticed that they showed a greater tendency to oviposit in the sunshine than when the cages stood in much shade. This is also the case in the field.

NATURAL ENEMIES OF LIOTHRIPS URICHI, IN TRINIDAD.

When, in 1922, Urich discovered *Liothrips urichi*, he also found that it had several natural enemies, being attacked by a Chalcid, *Tetrastichus thriphonus* and two predators, both undetermined, one a Reduviid and the other a Cecidomyid. More recent workers do not seem to have found these checks

on the number of the thrips much in evidence. Taylor states: "Urich has bred a Chalcid parasite, *Tetrastichus thripophonus*, Wst, from the prepupæ of *Liothrips urichi*. No other natural enemies are known. We did not find this parasite, and believe it to be uncommon as a rule."

Cook states: "*Liothrips urichi* has very few natural enemies, a small hymenopterous parasite and two predators, a Cecidomyid fly larva and a small brown Reduviid bug, all discovered by Mr. Urich, are the only ones known." He goes on to say that he only found one of these, the Cecidomyid, and that this: "was only observed on comparatively few occasions."

In the course of the very large amount of material examined on this Mission it was found that natural enemies were more in evidence than earlier workers had believed, several additional species being met with. The most important was undoubtedly the Cecidomyid, which was often very abundant, there being sometimes as many as three larvæ on one leaf. In these cases they quickly destroyed all the thrips present, attacking these in the nymphal stage and it was concluded that, whilst perhaps not actually specific, this insect was a special enemy of the thrips and that it probably destroyed 30 per cent. to 40 per cent.

The Reduviid was found as a somewhat scarce predator and may be a general feeder. It was present in the breeding cages, where the eggs were discovered. These are a pinkish-yellow, shaped like a soda water bottle, with a white fringe around the operculum and were found two side by side on the surface of the main terminal of the plant.

The Chalcid was met with only on one occasion and is evidently not abundant upon this insect, but there is reason to suppose that it may have other hosts.

In addition to these already known enemies of the thrips several new ones were met with. The most important of these was a predatory mite, shown in Fig. 9.* It is crimson in colour and hard to find as an adult as it had a habit of jumping from a leaf when this was touched. It was observed to attack both nymphs and adults. Being exceedingly small it easily escapes observation and this makes it difficult to estimate the extent of its attack.

A small black bug, rather larger than an adult thrips, which it decidedly resembles, was observed to suck the eggs of the thrips and occasionally destroy the pupæ. This species was only discovered towards the end of the investigation and the extent of its influence is unknown, but one bug is capable of destroying a very large number of the thrips.

In addition to the above which may be special enemies of the thrips, several general predators were observed feeding upon this insect. One of these, a small jumping spider, was not uncommon, but its effect would be hard to estimate. Another was the green larva of a Syrphid fly, which could destroy as many as seven nymphs in a night. This fly was not reared to maturity and was only met with on about three occasions. Ladybirds were also bred out of infected material and may destroy a certain number, but were more likely predatory upon scale insects.

From the above it will be seen that *Liothrips* has in Trinidad a considerable number of natural enemies, the elimination of which should greatly increase its efficiency in Fiji. There are, however, in the latter country several species of thrips, which are all rare insects, and may have special enemies holding them in check. In this case it is possible that some of these may turn their attention to the new introduction and thus offset the effect of such screening out. This, however, can be tested only by time.

* Figures not reproduced.

Fungus destroys a certain number of both nymphs and adults and on one stem of *Clidemia* gathered in the wet Aripo Valley five out of nine had been destroyed by this agency. This fungus caused considerable losses in my breeding cages and is probably allied to *Sporotrichum globuliferum* which which often proves very fatal to the cacao thrips.

CLIMATIC CONDITIONS DETRIMENTAL TO THE THRIPS.

Liothrips urichi is reported as being more abundant in the dry season than in the wet. The writer was in Trinidad mostly in the wet season and his experience tends to bear this out. It was observed that whilst the thrips was to be found all over the island it was very scarce at this season of the year in the wet Mora Forest and along the Cumuto Road, in the Central Ranges whilst it was far less common in the wet Arima Forest than in some other parts, considerable clumps of the plant being free. In such localities the plant grew into tall bushes 6 or 8 feet high, but was no more abundant than in other places where the thrips led to a stunted growth. It was also observed, both in the laboratory and in the field that the insect did not like dense shade, and did not oviposit freely in such situations.

Those districts in Fiji in which *Clidemia hirta* has become such a pest are considerably wetter even than the Mora Forest, and it remains to be seen whether there are favourable factors which will compensate for this somewhat unsuitable climatic environment.

THE NATURAL CONTROL OF CLIDEMIA HIRTA AND ITS ALLIES IN TRINIDAD AND FIJI.

Three and a half months were spent in collecting and preparing the material which was to be sent to Fiji and, whilst carrying out this work, it was decided to investigate further the causes which inhibited the spread of *Clidemia hirta* in Trinidad, as it was felt that there were other and more powerful agencies present than the thrips. Further it was observed that the thrips did not thrive in certain wet districts and this intolerance of wet conditions suggested a possibility that the insect might not thrive in the far wetter climate of Fiji. In view of the seriousness of the weed in Fiji it was felt that every effort should be made to ascertain whether any other agencies were present, checking the spread of the plant in Trinidad. The resulting investigations were attended with a considerable measure of success and a number of discoveries made regarding the biological control, not only of *hirta*, but of all the members of the genus, and resulted in conclusions greatly at variance with those previously held.

Habitat.—The *Melostomaceæ*, to which order the genus *Clidemia* belongs, are a dominant group in the West Indies, being rich in both numbers and species. They occur as small shrubs, similar to *Clidemia hirta*, up to bushy trees 12 or 15 feet in height. They require a good deal of moisture and in Trinidad form a considerable portion of the secondary growth about the foothills.

Clidemia is represented by a number of species, the commonest being, *pustulata*, *hirta*, *dentata*, *rubra* and *neglecta*. All these have similar habits, being found along the forest traces and in the partial shade of secondary growth and in clearing in the jungles. None of the genus was ever seen in the dense masses characteristic of *C. hirta* in Fiji, but both *pustulata* and *hirta* were abundant in places, the former being the only member of the group to occur anywhere in such numbers as to constitute a weed. This it did in two or three places, notably in a clearing in the poor land near the railway at Arima and again near Sangre Grande, in what is known as the Long Stretch, where it formed a considerable portion of the growth along the edge of the road.

Competition.—It has been suggested that competition of other plants is an important check upon the spread of this other and weeds and Cook gave a list of the plant association in which *hirta* was found. There is no doubt that competition is a factor, but the present investigations indicate that this competition takes its most intensive form in the effort of the plants to produce sufficient seeds to overcome the losses, which will be indicated later, and thus to reach suitable habitats as they become exposed. Once the seedling is established in its new haunt it seems capable of competing with the secondary growth, and produces seeds until such time as a new competition arises, caused by the growth of taller vegetation, which nursed under the shelter of the secondary, sun loving plants, eventually shades them out.

Ecology.—It has also been suggested that ecological factors were the paramount ones in deciding the relative abundance of the various species in any plant association. The present investigations, however, indicate that it is the biological factors which control the numbers, although of course the ecological factors will decide whether a plant shall be actually present in, or totally absent from any locality to which its seeds have access. It seems also probable that where the ecological conditions are only partially favourable that the plant will be replaced by other more suited species, rather than that it will continue to exist in small numbers only.

In any case, when a plant has invaded a new country to the extent to become a major noxious weed, it shows that the ecological conditions are favourable and, as in most cases, it would be impossible to change these permanently over any considerable area, it is only from biological methods that relief can be hoped.

BIOLOGICAL AGENCIES.

In approaching the matter from a biological standpoint three main lines of study suggest themselves:—

1. Those factors which assist the seeds to occupy quickly any suitable positions that become vacant.
2. Those factors which lead to the destruction of the seeds either before or after production.
3. Those factors which weaken the plant sufficiently to reduce seed production.

To deal first with those agencies which assist the spread of the plant in Fiji. The fruits of the various species of *Clidemia* are small purple berries, much relished by certain birds. Jepson has shown that the small seeds pass through the alimentary canal undigested and are thus distributed. There is little doubt that it was the presence of the Indian Mynah bird which, haunting cultivated lands and pastures, led to the very rapid spread of the weed in Fiji. It is of interest that the same bird is also considered the main agency in the spread of another weed, *Lantana* in that country. Other birds also assisted in distributing the new plant, particularly doves and pigeons and these are probably the chief agencies in the bush and forest country.

AGENCIES WHICH CHECK THE SPREAD OF THE PLANT IN FIJI.

Ecologically Fiji proved highly favourable to the plant, which rapidly occupied large areas in the wetter portions of the group. There have, however, been a few reports of the plant dying out from areas where it formerly flourished. The first of these was in 1919 and was investigated by the writer. The cause of the death of the weed proved to be connected with the attacks on the roots by a nematode of the *Heterodera* group, either

directly or indirectly by allowing the entrance of parasitic fungi. The disease was found to be confined to certain of the poorest classes of land, and whilst one or two other reports of a similar nature and due to the same agencies have come in, it has always been on the same poor type of soil and of little economic value in the control of the plant.

AGENCIES WHICH ASSIST IN SPREADING THE PLANT IN TRINIDAD.

In Trinidad doves are numerous and I am informed that the berries of these plants are often to be found amongst their stomach contents. These are forest and tree loving birds and whilst there are doubtless other species which feed upon this class of berry, there does not seem to be any with quite the same habits as the Indian Mynah to spread the plant over pastures and cultivated lands.

AGENCIES WHICH ASSIST IN PREVENTING THE SPREAD OF THE PLANT IN TRINIDAD.

In studying those causes which prevented this plant spreading unduly, it was frequently noticed towards the end of the wet season that there were numerous patches of bare soil along the forest traces, frequently damp and moss clad, ideal as seed beds for *Clidemia hirta* and its allies, which were unoccupied, and which would, in Fiji, produce quantities of young seedlings of the plant. Their absence in Trinidad did not suggest that the position was unsuitable, but rather that the seeds were not there to occupy the favourable situation thus exposed. In support of this conclusion Taylor states in his report on his investigations into the natural control of the plant in Trinidad: "We were impressed with the scarcity of fruit on *Clidemia* all over Trinidad," suggesting as a reason that "the thrips certainly plays an appreciable part in producing this state of things." Whilst agreeing as to this scarcity of fruit I was not satisfied that the thrips was the principal factor in bringing it about for the following reasons:—

1. The thrips was absent from all other species of *Clidemia*, yet the same failure to produce seeds was equally noticeable in these.
2. The thrips was absent or almost absent in certain wet districts and under the shade of cacao at places, yet although the plant grew luxuriantly it showed no signs of spreading unduly and there was still the same paucity of berries.

It was felt that the key to the position lay in the absence of seeds and investigation of the causes showed, that from the moment that the buds are formed until they reach maturity they are subject to the attacks of a series of insect enemies, which exert a pressure so severe as to result in the destruction of probably over 95 per cent. The conclusion was arrived at that it was seed destruction that was preventing the undue spread, not only of this plant, but also of all other species of the genus.

These controlling agencies were found to belong to a number of different species and even to different orders; some general, some specific and other apparently generic in their feeding habits.

INSECTS WHICH DESTROY THE SEEDS OF CLIDEMIA HIRTA, IN TRINIDAD.

Of those insects which destroy the seeds of *Clidemia hirta* the most abundant is probably a small Chalcid, which forms hard galls within the berries. At the time of my arrival it was present in probably 95 per cent. of all berries which reached full growth, but as the dry season advanced it grew scarcer, possibly due to an increasing wave of parasitic pressure and several localities were found from which it seemed to be absent. The effects

of its attacks varied with the size of the berry and the number of the insects present. If the attack did not take place until the berry was nearly full grown, and only one Chalcid was present, this gall was generally in the central pith and little damage seemed to result. If, however, the attack took place earlier it generally resulted in the premature fall of the berry, whilst if, as was usually the case, a number of galls were present in the same capsule, there took place a hardening of the tissues together with premature ripening, and loss of healthy seeds. Such berries were generally enlarged and very distorted. This Chalcid (Fig. 11) was subject to the attacks of a second Chalcid (Fig. 10) which was very abundant whilst a Braconid also occurred. This valuable species seems to be absolutely confined to *C. hirta*.

Lepidoptera.—Next to the Chalcid the most numerous of the seed destroying insects was a very small pink caterpillar. As a destroyer of seeds this was possibly the most important single agency. It was found commonly in the seed capsules of both *hirta* and *pustulata*, probably also attacking the other species of the genus. It showed a preference for the younger berries, but also attacked older and even ripe ones, causing them to fall prematurely, with total destruction of their contents. When fully fed the larva leaves the berry and spins a tough silken cocoon at the junction of two veins of a leaf or in a shallow in the stem, weaving a few hairs from the plant into its shelter.

The most remarkable thing about this insect is, however, that there is on *C. pustulata* a moth which forms galls in the stem, but which is never found in *C. hirta*. This moth is morphologically indistinguishable from this insect, but does not leave the shelter of the gall to pupate, whilst the caterpillar seems to be more variable. It seems probable that it is biologically distinct as its incidence did not always correspond with that of the seed-eating form. (See Figs. 17 and 23, resting position, also Fig. 22 larva.) Almost as abundant was a small greenish white caterpillar, resulting in the grey moth shown in Fig. 16. It attacked the berries at stages, causing them to fall off prematurely resulting in their total loss. This or a closely allied species was found to be the most abundant of the seed destroying agencies in the patch of *Clidemia* examined in British Guiana. Whilst what may be the same species was observed, but not bred out, feeding beneath the flower buds of *C. pustulata*, causing them to fall without opening.

In Fig. 15 is shown a pretty pinkish moth which was bred from an external feeding green larva and also from internal white ones. Time did not permit of checking this over and it seems probable that a mistake has occurred. The larva in the laboratory spun its cocoon as a rule between two berries. It was found (unless some confusion of the species has occurred) to be parasitised by a brown Braconid, shown in Fig. 12, which pupated within the berry. It is not always easy to be certain to which larva these internal species belong, as if removed from their surroundings they will seldom return and the breeding of the moth from the green external feeder suggests that an error has been made, although it is possible that the species is occasionally external in its habits, and the effect of the light is to bring out the green colour.

External Feeding Lepidoptera.—*Siderus leucophagus*.—Fig. 19 top and underside; Fig. 18 larva. The larva of this beautiful butterfly was found feeding upon the flowers and berries of *C. hirta*. The butterfly was never seen, but the larvæ were found from time to time. They match their surroundings most perfectly and were very difficult to discover. Like all the group it suffers much from the attacks of enemies and in the laboratory a nematode (*Mermis* sp.) was bred out. Its attacks on the berries resulted

in their total destruction, as they hollowed the interior completely out. Although rare in Trinidad, in another country, relieved of its natural enemies it might become of considerable value and it has the advantage of belonging to a group usually highly specialised in regard to feeding habits.

Fig. 13 is another external feeder. The larva is generally pink speckled with black, but is somewhat variable. As a rule it spins the flowers together and feeds upon the buds and young berries. One specimen was met with right inside a berry. The moth was first bred out by Ulrich. It is a most remarkable insect, with immensely long labial palpi, which are banded black and white, and are curved back over its head. The legs are also decorated in the same striking contrasts.

Another external feeder is shown in Fig. 21 (adult) whilst the larva is shown in Fig. 20. It was found in wet Arima reserve. The larva possesses very attenuated thoracic segments, and feeds by making a small hole in the side of a berry and completely clearing out the contents. It also constructs a funnel of silk, within which it lives and pupates. The adult moth is very beautifully coloured in brown and a metallic shade of silvery white.

Leaf Feeding Insects.—A number of insects were found to feed upon the foliage of the plant, but none would be safe to introduce into another country. In the field the most frequently seen of these leaf insects was the Pyralid moth shown in Fig. 14. The larva of this species is a leaf roller and was found to be not uncommon.

A second species made a hard case out of silk, recalling the cocoon of the European Puss Moths. This larva was brown with a yellow stripe on each segment and lived within the case, leaving an opening at each end to allow it to come out to feed. When full fed it closed the two ends forming a barrel shaped cocoon and pupated within.

Another lepidopterous insect was a leaf miner. This was not bred out and was, in Trinidad, of no importance.

A few specimens of a curious phytophagous beetle were bred in the cages and subsequently met with in the field.

Three homoptera proved troublesome in the cages. The worst of these was a species of *Aleyrodes* (white fly) which not only destroyed the foliage, but attracted ants. Next, in point of numbers, was a mealy bug, which became very bad in one or two of the cages, whilst the last of this group, also in the cages, was a yellow scale, of the *Lecanium* type.

Fungus Diseases.—In one or two of the wetter valley a fungus was observed on the foliage. This was identified as an *Irenia* sp., a group described as mildly parasitic.

INCIDENCE OF THE VARIOUS CONTROLLING FACTORS.

It was observed that the incidence of the various controlling factors varied greatly. Thus, in several of the wetter districts, such as the Mora Forest, the Arima Reserve and some portions of the Central Ranges, the thrips was practically absent. In these localities the weed grew into fine bushes six and even eight feet high. In the Central Range locality the gall Chalcid was also missing and control was almost entirely by the internal and external seed caterpillars, principally by the pink one. In a batch of berries collected in the Maracas Valley the white larva producing the moth shown in Fig. 16 was the most abundant species. It was also observed that as the dry season advanced there was a considerable change in the insects attacking the plant.

EFFECT OF INSECT ATTACKS UPON SEED PRODUCTION IN CLIDEMIA HIRTA.

A large number of berries of *Clidemia hirta* collected in different localities were opened and an examination of the contents made. A typical specimen will be detailed here, and it is proposed to tabulate a few others as an appendix.

The branch in question was taken from a fine plant, some six feet high, growing in the wet Arima Forest. It was one of a group that were free from attack by thrips, but although evidently long established there were no young plants found and the group was not apparently spreading with any rapidity. On this branch there were three fruiting bunches, the oldest consisting of only two berries, about half grown and both completely eaten out by lepidopterous larvæ. There was no doubt that the others on this bunch had all fallen prematurely from insect agency.

The next younger bunch consisted of eleven berries, six being green and five brown. Of the green ones four contained caterpillars and two were still sound, whilst all the brown ones had been eaten out by caterpillars. In the youngest bunch there was an unopened bud and one flower, both normal. There was one sound berry, six brown buds, five having been hollowed out by caterpillars and five green berries also containing caterpillars.

It will thus be seen that exclusive of the buds and flower, there were twenty berries, of which only three were still sound and these would still have to run the gauntlet of further caterpillar attacks and as they reached half size, become liable to the attacks of Chalcids. It will thus be realised how heavy is the pressure exercised by these seed-destroying agencies and the conclusion was forced upon me that it was considerably over 95 per cent. of the possible production that was thus destroyed perhaps over 99 per cent. In British Guiana it was noticed that the bud and flower destroyers were not so much in evidence and that the plants set far more berries. The pink caterpillars was not found, but is doubtless present in places. As a consequence there were far more berries, but these were nearly all attacked by the greenish-white larva, with what ultimate effect I was, however, unable to ascertain. The destruction must, however, be very severe.

CONCLUSION.

In Trinidad the plant *Clidemia hirta* is subject to a considerable number of insect enemies, which prevent its undue spread. The most important of these seem to be those species which destroy the flowers and seeds. These collectively seem to destroy over 95 per cent. of the possible seed production. This destruction is common to all the members of the genus, but the casual agencies are not always the same. *C. hirta* alone seems to be attacked by the gall seed Chalcid and, with the single exception of the *C. dentata* record, is the only host of the thrips. Whether this is offset by an ability to produce a greater quantity of seed than other species of the genus I would not like to say, but it did seem that *hirta* and *pustulata* were more continuously in flower than the others.

It was found that the value of the thrips as a control was much reduced by its own natural enemies and every effort was made to reduce as far as possible the numbers of such gaining access to the cages. If success is attained in screening these out the efficiency of the insect should be greatly increased; but, in Trinidad, *Liothrips* was particularly susceptible to wet conditions and as the areas of Fiji in which *Clidemia hirta* is found are, as a rule, very much wetter than Trinidad, it remains to be seen whether any success that has been met with in screening out natural enemies will be

sufficient to offset this probable unfavourable environmental condition. Should, however, it be found that the effect of the thrips in Fiji is not so great as could be desired the insects discovered in the present Mission and discussed in this report offer encouraging prospects of eventually being able to bring this troublesome weed under close biological control.

In the Appendix will be found details of—

- (1) Seed Examination.
- (2) Temperature Experiments.
- (3) Technique.

THANKS.

In conclusion I would like to express my sincere thanks to Col. G. Evans, Director of the Imperial College, who placed a laboratory at my disposal and extended much hospitality; to Professor H. A. Ballou, for kind assistance and advice; to Mr. S. M. Gilbert, Acting Director of Agriculture, who also rendered every assistance in his power.

I am particularly indebted to Messrs. F. W. Urich and R. O. William, who placed their great knowledge of the local entomology and botany at my disposal, besides assisting in many other ways. I have also to thank Mr. R. Dick for naming specimens.

My sincere thanks are due to Mr. B. Martyn, Mycologist, British Guiana, who assisted in the very wet and dirty task of obtaining the plants from that country, and to the Government Entomologist, Mr. L. D. Cleare, for kind hospitality.

I am also greatly indebted to His Excellency Col. Burgess, Governor of the Canal Zone, who instructed that my cages should be railed from Colon to Balboa free of cost to this country.

Finally to Dr. J. Zetek of the Department of Agriculture, stationed at Panama Canal Zone for kind hospitality and assistance, as also to Captain Jones of Andrews & Co., and Mr. W. Smith of Elders & Fyffe, for assistance in shipping my cages.

H. W. SIMMONDS,

Government Entomologist.

APPENDIX A.

TECHNIQUE FOR HANDLING LIOTHRIPS URICHI.

Previous workers have removed adult thrips by means of a blunt pointed needle, a tedious and slow method, resulting in the injury of a number of the insects. Effort was therefore made to evolve a more satisfactory system and the following was found to work well:—

Infected material was collected in the field and carefully gone over with the lens, any adults present being removed by means of the needle. The leaves were then roughly sorted into two lots; one, in which pupæ predominated, and the other consisting of nymphs. The former was then allowed to dry off for about 36 hours, when it was placed into a closed tin, interlaid with portion of fresh leaves and left for a night. The nymphs soon left the dry material for the fresh, whilst the pupæ remained behind, so that a pure culture was obtained of pupæ on the one hand, on the dry leaves and of nymphs on the fresh. The pupæ were then placed into a box until the commenced to emerge, when a few fragments of leaves that had been carefully examined with the lens for undesirables were introduced and kept closed until next day. It was then found that the newly hatched adults would have collected on the fresh leaves, and in this way could be handled in large numbers without loss.

When a fair number of pupæ had collected amongst the nymphs these were again dried off and the pupæ separated from the remaining nymphs.

By using mason jars or tins food could be kept sufficiently fresh for a number of days. It was, however, found necessary to open up the jars each day, otherwise sufficient carbon-di-oxide was given off to kill all life present.

TEMPERATURE EXPERIMENTS.

In order to test the value of cooling to assist in the transport of any material that may subsequently be required, one or two temperature experiments were carried out:—

1. A set of berries, numbering 96, were placed in a cool chamber at a temperature of 53° Fahr., remaining there ten days. When removed Chalcids commenced to emerge at once and continued to do so for 18 days. From this it seems that the effect of this temperature is only slightly to delay development, regardless of the stage in which the insect is at the time placed in the cooler. In addition, four moths emerged on the 18th and 20th days. It seemed to show that these insects could only stand chilling when in one stage, possibly egg or possibly pupal, followed by delayed development.

2. A second box containing fully developed nymphs and pupæ of *Liothrips urichi*, was subjected to similar treatment for twenty-one days, all surviving.

APPENDIX C.

RECORDS OF SEED EXAMINATIONS IN CLIDEMIA HIRTA.

In addition to the records of seed destruction given in the text a large number of berries were cut open and a record was kept of a few of the more interesting of these, some of which are detailed below:—

1. A set of twelve berries, almost ripe, were collected from the plant and opened up, when it was found that all had been attacked by insects, six being caterpillars, five Chalcids and one by both.
2. Four berries from under the plant in the Mora Forest were found to contain caterpillars in three and the fourth had one of the only two thrips met in that wet area.
3. Twenty ripe berries collected under bushes in the Northern Ranges consisted of five sound ones, seven containing Chalcids, five of which were quite destroyed and seven totally destroyed by caterpillars, whilst two had dropped from some unknown agency.
4. Twelve seeds picked up under bushes in the Northern Ranges had all been destroyed by caterpillars and Chalcids in equal proportions.
5. Six buds found under the same bushes had all been attacked by insects.
6. Thirteen buds and young berries found under bushes at Arima had, in eleven cases, been eaten out by caterpillars and one had an external wound.
7. A large batch of full grown berries gathered at Maracas were about 95 per cent. attacked by Chalcids, with caterpillars also present.
8. Forty-three berries from under plants at St. Johns consisted of 23 destroyed as recently set buds, probably all the work of caterpillars, eleven eaten out by the same agencies, three contained both caterpillars and Chalcids and five contained Chalcids only. Of the balance four were big berries totally destroyed by external feeders and five contained Chalcids or caterpillars, but had not been so severely damaged and might mature a few less seeds. There was not a sound berry in the whole lot.

MARKETING OF FIJI FRUIT IN NEW ZEALAND.

By JAMES KERMACK, Assistant Superintendent of Agriculture and Inspector of Produce.

As directed by His Excellency the Governor, I proceeded to Auckland, New Zealand, by the s.s. "Tofua," on 13th February, for the purpose of observing conditions under which Fijian fruit is carried, discharged, and marketed in New Zealand, and of investigating market conditions in regard to bananas and other produce. After careful observations, which were continued over a period of approximately three weeks, of the various operations relative to

the transport and ultimate distribution to retail merchants of banana consignments, which was the primary object of my mission, and from investigations I made regarding possibilities of markets in New Zealand for a much larger export of produce from the Colony I submit the following information:—

TRANSPORT OF BANANAS TO AUCKLAND.

2. The steamer on which I travelled carried 6,160 cases of bananas put on board in four holds at Suva on the 16th and 17th February, and consigned to the undermentioned Agents and fruit buyers in Auckland:—

A. B. Donald, Ltd.,
Turners and Growers, Ltd.,
Radleys, Ltd.

The fruit, the greater part of which had been harvested at least four days prior to shipment, was on arrival at the wharf at Suva found to be in an unsatisfactory condition. A considerable percentage was overfull and commencing to ripen, whilst a proportion was immature and diseased and although several shippers endeavoured to improve matters by repacking, the danger of the cargo reaching New Zealand in a poor marketable condition was only too obvious. Loading operations left a great deal to be desired in respect of proper handling and I am of opinion that a discontinuance by the Steamship Company of the present "rope sling" system and by substituting "trays," the risk of cases being damaged and consequently fruit bruised by crushing, would be considerably lessened. Every care was, however, taken by the ship's officials in the stowing and dunnaging of the cases and as there was ample room in the holds for a very much larger shipment, ventilation was good and gas from ripening fruit was readily expelled by a fan system which operated from the time loading operations commenced and throughout the voyage to Auckland. I visited the holds of the vessel each day during the period of transport and found that whilst for the first two days there was little or no appreciable change in the appearance of the fruit, a general ripening in many lines commenced on the third day. I attribute the early general ripening solely to the unsatisfactory condition of the fruit at the time it was put on board. Ideal weather conditions for transport did not necessitate the steamer holds being closed during any stage of the voyage and temperatures were even and comparatively cool from the time the vessel left Suva until Auckland was reached.

DISCHARGE OF CARGO AT AUCKLAND.

3. I observed very closely unloading operations which commenced soon after the vessel was tied up alongside the wharf at Auckland. A considerable amount of care was exercised in discharging the cargo on to the wharf on "trays" but I was by no means favourably impressed with the manner in which it was handled by wharf labourers from the ship's side to Customs sheds, cases being frequently lifted from hand trolleys by which means they are transported and literally thrown one on top of another in different piles. I complained on several occasions to the Fruit Inspector who was on duty about the rough treatment the fruit was subjected to and was informed by that official that any interference on his or the Shipping Company's part would probably result in a general strike of wharf labourers, all of whom are associated with strong Unions.

INSPECTION OF FRUIT IN CUSTOMS SHEDS.

4. As I had anticipated, a large proportion of the shipment was found to be in bad condition and shipper's agents, who I learned make as a rule a cursory examination only of the fruit in Customs sheds, experienced on

this occasion great difficulty in selecting from the different lines the quantity of cases of what they considered to be sound fruit ordered by clients for immediate delivery. No systematic inspection was made by the Government Fruit Inspector and approximately 50 per cent. of the cargo was distributed from Customs sheds immediately after shippers' agents had made their Survey. I inquired of the Fruit Inspector the source of information he supplied periodically to the Department of Agriculture, Suva, in regard to the condition of shipments arriving in Auckland from Fiji throughout the year and he reluctantly had to admit that it was supplied to him by an official of one of the shippers' agents. This admission did not come altogether as a surprise to me after I had been in the Customs sheds but a short time. I do not suggest that the information submitted by the Fruit Inspector is unreliable but his method of procuring it is, in my opinion, irregular and may lead, if it is continued, to the Government of Fiji on occasions taking undue drastic action against shippers whose fruit may possibly have been adversely reported on by an agent's employee in error during the hurried period of distribution in the Customs sheds. The position, however, in regard to fruit inspection in Auckland at present would appear to me to be a difficult one as the Inspector is expected by Government to do the work without any assistance whatsoever. To make a thorough inspection of each line of fruit in the short space of time available prior to distribution, a fairly large staff of competent inspectors would, in my opinion, be necessary.

REPACKING OF FRUIT IN AGENTS' SHEDS.

5. I have already stated that approximately 50 per cent. of the cargo was distributed without proper examination. The remaining 50 per cent. was trucked to the sheds of the different agents where cases were emptied, fruit graded, repacked and sold either by auction or by private sale. I followed closely each operation and was favourably impressed with the careful and expeditious manner in which the fruit was handled. Considering the speed and accuracy with which the culling and grading was carried on it was perfectly obvious to me that a number of specially trained employees are on hand at all times to do this class of work. This would mean that repacking of indifferent fruit has frequently to be resorted to. Here I had also an opportunity of arriving at an estimate of the condition of the shipment. On the assumption that a high proportion of the 50 per cent. distributed without inspection was in a similar condition to the proportion repacked and from my observations in the Customs sheds it may reasonably be inferred that the shipment was the worst since the new Banana Regulations came into force in Fiji in September, 1928. The following statement compiled from notes I made in course of my observations in repacking sheds compares favourably with information I was able to procure from shippers' agents and therefore may be accepted as being correct:—

Total shipment	.. .. .	6,160 cases
Sold without examination	.. .. .	3,023 cases
Examined and found to be in the following condition—		
Green	.. .. .	1,558 ..
Ripe and soft	.. .. .	747 ..
Over-ripe, immature and diseased	.. .. .	832 ..
		————— 6,160 ..

MARKETING IN CUSTOMS SHEDS AND IN AGENTS' PREMISES.

6. The maximum price governed more or less by supply and demand is arranged by mutual agreement between shippers' agents when they have

ascertained the extent of the shipment and after they have roughly estimated the condition of the fruit. I was not able to find out for what price unexamined fruit sold, but I had some evidence that about 27/6, which I was informed was the maximum on this occasion, was obtained. In the agents' auction rooms prices for repacked fruit ranged from 12/6 to 27/6 according to condition and averaged, as near as I could estimate at times when I attended auctions, 20/- per case. I was satisfied that sales of repacked fruit in agent's premises by auction were conducted in a perfectly straightforward manner and I have no reason to doubt that other sales made by private bargain in Customs sheds and elsewhere were similarly conducted.

VISITS TO RETAIL STORES.

7. Periodically during the first week of my stay in Auckland I visited the principal retail stores in and around the city and from observations I made merchants appeared to have little or no difficulty in disposing of bananas at prices ranging from 4d. to 6d. per lb. It would be difficult to estimate the return to the retailer as occasionally the smaller and poorer fruit I observed was offered for sale by quantity at so much per dozen but I was satisfied that sales by weight of repacked fruit from agents' sheds must have been profitable. The net weight of a case of sound bananas is approximately 80 lb and as the estimated cost to the retailers on this occasion was 20/- per case, a gross profit from sales at an average price to the consumer of 5d. per lb would be 13/4 per case. In considering this apparent high return it must, however, be borne in mind that the retail merchants run considerable risk in stocking ripe bananas during the warm season and are liable to lose through the fruit going bad if there is not an immediate demand. I questioned several of the leading storekeepers regarding banana sales, and all were of opinion that if the fruit were available and could be imported and sold to retail merchants at a reasonable price a very large business would result. In this I quite agree as frequently I overheard remarks of intending purchasers who hesitated to buy on account of high prices asked.

VISIT TO WELLINGTON.

8. After I had studied, for over a week, the situation in Auckland I proceeded to Wellington where I spent four days. Market conditions there, in respect of prices, I found on inquiry to be very similar to those which obtained in Auckland. Unfortunately I had no opportunity of seeing any bananas landed or auctioned in Wellington, but I was informed that only small consignments reach that port principally from Rarotonga and Samoa. When available a quantity of Fiji bananas is despatched by rail each month from Auckland, and I gathered from retail merchants that no difficulty whatsoever is experienced in disposing of such even at high prices. With letters of introduction from the Hon. the Colonial Secretary, I called on the Director of Agriculture and the Comptroller of Customs. The latter official was not on duty when I called and I had not an opportunity of seeing him before I left the city. I met his deputy, however, and whilst both he and the Director of Agriculture showed me every courtesy neither official could assist me very much in my investigations of local marketing conditions. I had a long and interesting conversation with the Director of Agriculture, Dr. Reakes, who was very sympathetic in his attitude towards importations into New Zealand of Fiji produce.

RETURN TO AUCKLAND FROM WELLINGTON.

9. I returned to Auckland on 28th February and had an opportunity the following day of seeing a shipment of approximately 6,000 cases of

Samoan bananas landed from the New Zealand Government boat "Maui Pomare" an insulated vessel specially constructed for the carriage of fruit. It was interesting to compare the shipment with Fijian consignments of the previous fortnight to Auckland and I regret to record that the condition of the Samoan fruit was by far superior. As near as I could estimate 15 per cent. only was yellow but not over-ripe whilst the remainder appeared to be green and firm.

INVESTIGATIONS REGARDING POSSIBILITIES OF LARGER MARKETS IN
NEW ZEALAND FOR FIJI PRODUCE.

10. I employed the remaining few days of my visit to New Zealand investigating possibilities of increased markets for Fiji bananas and other produce and discussed the question with several of the leading fruit agents and merchants in Auckland. Without exception all were most enthusiastic over an extensive development of the banana trade. The public, they contended, are clamouring for bananas and insist on having the Fiji product but at a cheaper price. At present the fruit is an expensive luxury almost outside the reach of the ordinary individual and if conditions remain as they are for much longer merchants claim that the working man, recognised to be the largest consumer will, of necessity, cease to be a purchaser. One of the leading Auckland fruit agents informed me he was satisfied that from 60,000 to 70,000 cases if not more of Fiji bananas placed on the market at a reasonable price would readily be absorbed in New Zealand each month if properly distributed among the larger cities. I do not for a moment doubt this assertion but whilst the public are demanding more fruit they also expect to get it of the best quality. Recent shipments to Auckland have not, I should say, been a good advertisement for Fiji bananas and in my opinion it has been due only to a shortage in the market that little difficulty has been experienced by merchants in making sales. Shippers have, I am afraid, in view of this shortage been too prone to fill cases with indifferent fruit which in normal times would be rejected by them as unsuitable for export and have not considered the necessity of maintaining the highest possible standard in order to foster what should be a much more important industry in the Colony. There would appear to be a very limited demand in New Zealand for tropical fresh fruits other than bananas and whilst I suggested to merchants different varieties which in time could be supplied by Fiji in large quantities if required, they were perfectly candid in stating that the public would not be interested. For citrus there is a good market, oranges, mandarins, Lisbon lemons and grape-fruit being imported in fairly large quantities from Australia and the United States of America. No attempt has been made by Fiji to cater for the citrus trade in New Zealand and I am of opinion that there is an excellent opportunity awaiting growers who would produce the best varieties and grade and pack the fruit in accordance with merchants' requirements. For Fiji vegetables there is not a keen demand. Kumalas and tomatoes would, I was informed, probably find a more ready market than at present during the New Zealand "off" season if the quality was of a higher standard but at the same time merchants warned against over production.

11. I concluded my observations and investigations on 10th March, and left Auckland the following day on the s.s. "Aorangi" for Fiji, arriving in the Colony on 14th March.

12. My thanks are due to many business firms and individuals in New Zealand who rendered me valuable assistance during my investigations.

MOULD DAMAGE TO COPRA.

By W. J. BLACKIE, M.Sc., Government Chemist.

The experimental results in this paper were found scattered through the records of the Agricultural Department and were obtained by the previous Government Chemist, C. L. Southall. The paper in its present form has been entirely compiled by the author who is responsible for the arrangement, introduction, discussion, interpretation of results and graphic representation. From the results and discussion herein described, experiments are now under way to study methods of alleviation of mould action on copra.

INTRODUCTION.

Copra as prepared by the less efficiently equipped producer in Fiji, is attacked by several species of moulds, notably *Aspergillus flavus*, *Aspergillus niger*, *Rhizopus* species and several species of *Penicillium*. The damage caused by these fungoid growths is in many cases quite considerable and the resultant product finds a poor market. Mould action is not confined to the surface nor does copra appear to be limited to the attack of one definite type of mould, but depending upon the season of the year and apparently on the humidity of the atmosphere which controls in no small way the rate of drying, fungoid growths succeed one another in establishing themselves on the drying material. It is usual to find a preponderance of one definite growth at a time although two or three may have succeeded in establishing themselves. The establishment appears, superficially, to follow a definite order in the majority of cases but this is not always so, and in some cases definite growths fail to make their appearance. Under these conditions it is usual to find copra badly attacked, due no doubt to unchecked development of the fungus through lack of competition; and in five or six days the mycelia especially in the case of *Aspergillus flavus* which appears to be responsible for most of the damage, have penetrated into the meat and decomposition ensues, commencing in proximity to the mycelia and gradually spreading throughout the material.

2. It is usual to note that certain types of drying meat are attacked earlier than others, drying under identical conditions. More especially is this so with germinated material and sometimes spore formation has taken place before the neighbouring meat is attacked. The possible explanation here is that enzymic action with consequent decomposition of fats, proteins, carbohydrates has produced a superficial medium suitable both in available food and hydrogen-ion concentration for the establishment of fungoid growths. In all probability the succession of growths is controlled by the increasing acidity of the material which also has its effect on the fungoid lipases and esterases or fat-splitting enzymes since these complex organic compounds, working under optimum conditions, have a fairly narrow P.H. range. Except in the case of the germinated nut, the surface of the fresh meat is neutral or only faintly acid and therefore it is considered that the work of destruction is commenced by bacteria (since bacterial lipase has its optimum at P.H. 7.2 to 9.0), followed by a definite succession of fungoid growths.

Summarising these observations it appears that mould action is influenced by—

- (1) humidity of the atmosphere which controls the rate of drying of the meat, and exposure to rainfall;

- (2) the preparation of a suitable superficial medium for the establishment of moulds either (a) before drying operations as in the case of the germinated nut or (b) through the action of bacteria on the copra;
- (3) the presence of sufficient moisture in the drying copra to take part in the hydrolytic processes.

3. Little is known with regard to the mechanism of the chemical reactions taking place during the decomposition of copra by bacterial and mould action. When it is considered that the reactions are taking place upon a complex substrate consisting chiefly of complex glycerides, but containing also protein bodies, various types of nucleotides, simple and complex carbohydrates, including cellulose, and various other products in minute amounts, it is readily understood how involved the problem is. The oil extracted from such copra must contain not only the free fatty acids liberated by the action of the lipase group of enzymes but also many other products resulting from the decomposition of proteins, carbohydrates, &c. About twenty-two or more distinct enzymes have been isolated from moulds (many of them from *Aspergillus niger*) and almost as many from bacteria. Among these are lipase, the fat splitting type, various types which act on carbohydrates such as: maltase, raffinase, cellobiase, lactase, diastase, inulase, emulsin, &c.; types acting on nucleic acids, e.g., nuclease and various types such as oxidase, reductase, catalase, all group-specific in their actions. The activity of these various enzymes is dependent in no small manner on the P.H. of the medium, maximum activity being displayed at definite P.H., slight deviations from which have a marked effect and no doubt many of the products produced act as inhibitors of certain types of reaction. The sum total of these different processes is to produce a coloured oil containing free fatty acids, and, as mentioned above, various other products in small amounts. Moreover the oil cake produced has suffered in nutritional value through loss of proteins and carbohydrates. The oil also develops the property of rancidity due both to further decomposition of the acids produced and also to the presence in it of proteins and other decomposition products. Coconut oil consists of mono, di, and triglycerides, of lauric, caproic, caprylic, capric, myristic, palmitic and oleic acids together with small amounts of certain of the esters of phytosterol. With regard to the action of the lipase enzymes on this heterogeneous system, little is known. The composition of the free fatty acids produced has not been determined with any great accuracy. Undoubtedly, certain of the groupings lend themselves more readily to attack than others such as the esters of the unsaturated acids, e.g., oleic, however, although different fats are not attacked at the same rates, owing to the large amounts of lauric acid combinations in the original oil, quantities of this acid would be freed in the oil by enzyme action.

4. In attempting to study the catalytic effects of lipase as a fat splitting enzyme acting on drying copra, one is faced with a varying concentration of substrate, varying hydrogen-ion concentration, and varying temperature. The latter could be controlled and superficially also the P.H. to a limited extent, but variations in substrate concentration and internal P.H. affect the velocity of the enzyme reaction. It would appear also that the accumulation of free acids appears at first to accelerate the reaction of fat splitting, added accumulation of acids slows it down until probably at a definite total free acidity, the enzyme action is destroyed.

This point is illustrated graphically (Graphs 5 and 6), of increase in acidity and logarithm of percentage increase of acids with time. Here it is seen that the amount of free acid reaches a maximum, and then decreases

in value. This decreasing value is to be explained by the utilisation of the free acid by the reverse process of fat formation, or else what appears more likely, their destruction by carboxylase with the production of CO and H₂O. These figures are taken from table (1) and are to be compared with those from table (4) obtained from copra made and stored under commercial conditions.

In graph 6A there is a distinct per cent. increase in acidity up to the 7th day, then a gradual decrease to the 21st day, then a more gradual decrease up to the 28th day. In graph 6B there is a rapid increase up to the 4th day, a more gradual increase from the 4th to the 7th, a more rapid increase comparable with the preliminary stage from the 7th to the 11th day and then a more gradual increase from the 11th to the 14th. This graph is very interesting as it seems to display distinct periods of activity and decline. This either points to (1) definite reactions taking place in order, (2) the establishment and specific action of four different growths, (3) definite equilibria between fat-splitting and acid utilisation. Graph (6C) further amplifies this phenomenon. In this case the logarithm of the per cent. acid increase from step to step is plotted against time. Here it is seen that after the 11th day there is a diminished per cent. acid increase between successive determinations. The four cycles are markedly displayed in this graph.

In order to form some estimate of the damage done to copra by fungoid action the following experiments were arranged and designed to determine the change undergone when copra was exposed to action of various moulds under conditions favourable to these growths.

EXPERIMENTAL METHOD.

Copra was formed from selected mature nuts by sun drying, and the resultant material grated. The meal was mixed thoroughly. The moisture content was determined and a weight equivalent to 15 grams of anhydrous copra weighed into each of 20 petri dishes. The grated copra was then sterilised by superheated steam at 15 lb pressure. Previous experiment showed that this method of sterilisation caused no loss of oil. In order to eliminate variable water content the grated, sterilised material was dried under sterile conditions and the water content of each dish carefully adjusted to 10 per cent. by means of sterile water. Eight of the dishes were then inoculated with a suspension of two species of *Aspergillus* (probably *Asp. flavus* and *Asp. niger*. This diagnosis is only provisional owing to lack of literature to assist identification in the Departmental Library) and *Penicillium glaucum*. The twelve dishes including four uninoculated as controls were placed in a feebly illuminated cupboard.

In order to obtain pure cultures the following method due to Mr. C. H. Wright, a former Government Chemist, was adopted. A sample of badly infected copra was pounded up with sterilised water under sterile conditions and the product used to infect a nutrient agar medium. The growths that resulted were carefully examined and spores from distinct species separated and used to inoculate fresh quantities of agar medium. By several such operations fresh cultures resulted. In order to obtain, as closely as possible, comparative conditions, the following method of inoculating the copra was used. A platinum loop was touched into a mass of spores in the pure cultures and transferred to sterile testubes containing 4 ccs. sterilised water. After thorough mixing one cc. was withdrawn and spread evenly over the copra in each petri dish, one cc. of sterile water without spores being added to the controls. Necessary adjustments were then made in each case for 10 per cent. moisture content.

Penicillium glaucum did not grow but the species of *Aspergillus* did so luxuriantly during the course of two weeks when a decline set in owing, no doubt, to accumulation of metabolic products. The material was badly attacked by the moulds owing to its physical condition, *i.e.*, increased surface for interaction with the mould enzymes. At the commencement of the experiment the quantity of oil and free fatty acids were determined accurately by analysis of samples from two of the remaining petri dishes also a sample taken from the unsterilised bowl of dessicated coconut. These three analyses gave almost identical results. Two inoculated and one uninoculated dish were withdrawn at the end of one, two, three and four weeks and oil and free fatty acid determined. The oil and free fatty acids were determined in the usual manner and the following results, table (1) obtained:

TABLE 1.

	Copro at Com. Exp.	After 7 days.				After 14 days.			
		Con- trol.	1.	2.	Mean	Con- trol.	1.	2.	Mean
Oil in anhydrous copra %	68.2	68.1	57.7	59.5	58.6	68.1	57.7	52.0	54.9
Acid as oleic in oil .. %	0.3	0.3	5.4	4.9	5.2	0.3	5.1	5.4	5.3
Loss anhydrous copra %	..	..	3.5	3.2	3.4	..	9.0	10.7	9.9
Apparent loss oil .. %	..	..	10.4	8.7	9.6	..	10.5	16.1	13.3
Actual loss oil .. %	..	..	12.5	10.6	11.6	..	15.7	21.7	18.7
Obscured loss oil .. ..	..	..	2.1	1.9	2.0	..	5.2	5.6	5.4

TABLE 1—continued.

		After 21 days.				After 28 days.			
		Con- trol.	1.	2.	Mean	Con- trol.	1.	2.	Mean
Oil in anhydrous copra %	68.0	48.8	47.1	48.0	68.2	45.3	49.5	47.4	
Acid as oleic in oil %	0.5	4.1	4.8	4.5	0.4	3.4	3.4	3.4	
Loss anhydrous copra %	..	11.0	16.0	13.5	..	17.3	14.9	16.1	
Apparent loss oil %	..	19.4	21.1	20.3	..	22.9	18.6	20.8	
Actual loss oil %	..	24.8	28.6	26.7	..	30.7	26.0	28.4	
Obscured loss oil %	..	5.4	7.6	6.5	..	7.8	7.4	7.6	

TABLE 2.

SIMPLYING THE ABOVE TABLE AND TAKING MEAN FIGURES.

Percentage—	One week.	Two weeks.	Three weeks.	Four weeks.
Loss anhydrous copra	3.4	9.9	13.5	16.1
Apparent loss oil ..	9.6	13.3	20.3	20.8
Actual loss oil ..	11.6	18.7	26.7	28.4
Obscured loss oil ..	2.0	5.4	6.5	7.6

N.B.—The figures for loss of oil are calculated on anhydrous copra.

On consulting the table, it is to be observed that there may be a variation of as much as 10 per cent. in oil content in anhydrous copra, between the two experimental dishes analysed in each period, probably due to quantity of growth. The mean result is taken in each case and compared with the control which had not varied within the limits of experimental error during the course of the month. The table is self-explanatory and needs no further discussion. Table (2) is a simplification of table (1) taking mean figures.

RESULTS OF EXPERIMENT.

The growth of the two moulds *Aspergillus flavus* and *Asp. niger* on grated coconut containing 10 per cent. moisture over a period of four weeks resulted in—

- (1) an apparent loss of 20.8 per cent. of oil, which, corrected for loss of copra, gives an actual loss of 28.4 per cent. oil;
- (2) a loss of 16.1 per cent. of anhydrous copra;
- (3) an increase in the acidity of oil during the first two weeks of from 0.3 to 5.5 per cent., followed by a decrease in the second two weeks to 3.4 per cent.

2. Concurrently with the above, a second experiment was tried. Copra prepared, shredded, and sterilised as in the first experiment, with its moisture content accurately adjusted to 10 per cent. was exposed on petri dishes for three hours in two bulk copra stores, three dishes in each store. The object of this experiment was to infect copra with spores normally present where copra is stored and to limit the degree of inoculation to a normal amount. After a few days a single mould appeared which seemed to be *Aspergillus flavus* and grew very slowly during the four weeks of the experiment. Control samples unexposed were kept as in experiment (1).

At the end of the period, 28 days, analyses were performed as before and the results are tabulated in Table 3:—

TABLE 3.

	Unexposed.		Exposed copra after 28 days.					
	1st day.	28th day.	Store "A."			Store "B."		
			1.	2.	3.	1.	2.	3.
Oil in anhydrous copra	68.2	68.1	66.7	67.3	64.7	66.9	65.8	66.0
Acid as oleic in oil	0.3	0.4	8.3	7.7	8.4	8.0	8.6	8.6
Loss anhydrous copra .. ..	..	..	4.3	3.0	4.1	3.9	3.6	3.6
Apparent loss oil .. ..	..	..	1.4	0.8	3.4	1.2	2.3	2.1
Actual loss oil .. ..	..	..	4.3	2.9	5.9	3.9	4.7	4.5
Obscured loss oil .. ..	..	..	2.9	2.1	2.5	2.7	2.4	2.4

N.B.—The figures for loss of oil are calculated on anhydrous copra.

RESULTS.

1. The actual loss of oil was relatively much less than in the previous experiment amounting to an average figure of 4.4 per cent.
2. The loss of anhydrous copra was much less, amounting to only 3.9 per cent. as an average figure.
3. A very much greater increase in free fatty acid, the average figure amounting to 8.3 per cent.

DISCUSSION OF RESULTS.

1. In considering the first experiment it is to be clearly understood that the results obtained could not be compared in a quantitative way with the results that would be obtained with copra made and stored under commer-

cial conditions. The reason for this is that (1) the density of the material, that is the mass per unit volume, was much less with the grated material than with normal copra.

2. A greatly increased surface was exposed to enzyme action in the case of grated material thus permitting penetration.

3. The cellular structure of the material was largely altered by the grating, thus permitting a more intense enzyme action on fats, carbohydrates, proteins and other bodies contained in copra.

4. The material was sterilised in the first instance and limited to the attack of one definite species of mould.

5. The degree of infection of the mould was much greater than would occur normally owing to unrestricted growth through lack of competition.

6. The moisture content 10 per cent., was initially high. In practice this would be transient since well dried copra averages about 5.5 per cent. in Fiji.

This experiment was designed to obtain the maximum oil loss by providing optimum conditions for mould growth, the moisture content of 10 per cent. being considered favourable to the two species of *Aspergillus*.

In experiment (2) an attempt was made to eliminate the objection discussed in (4) above, by permitting the grated copra to become normally infected with spores present in the atmosphere of the bulk copra stores, but this experiment also suffers both from the objections discussed above and from the fact that—

(a) there are very few air-currents present in a copra store, and hence infection by spores is at minimum;

(b) several moulds in series had grown on the bulk material during the formation of copra.

Therefore, the type present on the material in the bulk stores had established itself after a series of fungi had interacted with the material and as a result, had become unsuitable for establishment on the grated copra, which had been sterilised and kept free from mould action. This seems to be so from the fact that, although the surface of the grated copra open to interaction was much larger than with normal copra, only one fungus succeeded in establishing itself and grew very slowly during the four weeks of the experiment. From the consideration of the above results it was thought that a fairer estimate of the damage done, could be obtained by determining the losses resulting from copra prepared upon open "Vatas" as practised by producers in Fiji. The intention was to produce copra containing about 10 per cent. free fatty acid, this being the average acidity of Fijian copra, and with this end in view the copra was subjected to somewhat harsh treatment. To prevent evaporation, it was kept covered without much ventilation, when a moisture content of 10 per cent. was reached. This was assumed to correspond to the practice of removing semi-dried copra from the "Vata" to a large heap inside a shed.

DESCRIPTION OF EXPERIMENT.

Eighty-six pounds of fresh cut copra of known composition was spread on a "Vata" protected from rats and mongoose in two separate portions, one containing 50 lb and the other 36 lb. The smaller portion was for the purpose of daily sampling, in order that the approximate condition of the main heap could be determined. Ten pounds of the same copra was dried in a steam oven at about 180° F. Rain fell on the copra for a short time on the 3rd, 4th, 5th, and 9th days. During the night, the material was heaped under galvanised iron.

2. The copra soon became heavily infected with moulds, but they did not penetrate far into the mass until five or six days had elapsed. Mould attack was assisted by copra beetles which, by attacking mouldy spots and making fresh openings, increased the surface of interaction.

3. After fourteen days had elapsed, the copra was dried down to 5 per cent. water, carefully sampled and analysed. The copra prepared in the steam oven yielded the theoretical quantity of anhydrous copra which for the nuts used, amounted to 54 per cent. of the original weight.

TABLE 4.

	Time in days from the commencement of the experiment.							
	1.	3.	4.	7.	9.	11.	13.	14.
Loss of anhydrous copra ..	% ..	% 0.8	% 1.6	% 3.0	% 5.6	% 7.4	% 10.5	% 12.4
Oil in anhydrous copra ..	67.6	65.7	65.3	65.7	63.1	62.3	60.7	59.4
Actual oil loss .. ..	..	1.9	2.3	1.9	4.5	5.3	6.9	8.2
Free acid in oil (as oleic) ..	0.2	0.8	1.6	1.9	3.3	5.7	7.3	8.5

RESULTS OF EXPERIMENT.

1. The total loss of anhydrous copra was 12.4 per cent.
2. The increase in acidity calculated as oleic acid was 8.3 per cent.
3. The brown mould which appeared in quantity after the fifth day, *Aspergillus glaucus*, appeared to cause the most damage.
4. The experiment appeared to indicate that the main loss takes place not on the "Vata" itself but during storage before the moisture content falls below 6 per cent. If this should prove to be correct a much greater loss of copra than the 12.4 per cent. obtained in the experiment appears to be possible in many of the wetter districts.

SUMMARY.

In the introductory portion of this paper an attempt was made to indicate the complexity of the chemical problems connected with the decomposition of copra, chiefly by mould action. It is only by study in this direction and a thorough mycological investigation that attempts can be made, in an enlightened way, to counteract the destruction. From observations made of commercial samples and as a result of the experiments above described, surmises, at the present juncture, with regard to certain features underlying the *modus operandi* of this deterioration are advanced.

It was therein stated that—

- (1) the humidity of the atmosphere controls in no small manner the establishment and development of fungoid growths;
- (2) that moulds attack the copra in order and that it is usual to find a preponderance of one growth at a time;
- (3) that bacterial activity may be a precursor of fungoid activity. This is contrary to results obtained by others. (See Copeland "The Coconut");
- (4) that enzyme action is not alone limited to the destruction of the fats;

- (5) that a changing hydrogen-ion concentration controls establishment of moulds and the nature of subsequent enzyme action;
- (6) that where one growth preponderates under conditions favourable to it, destruction as measured by the decreasing oil content is generally, other things being equal, at a maximum for the experimental period concerned.

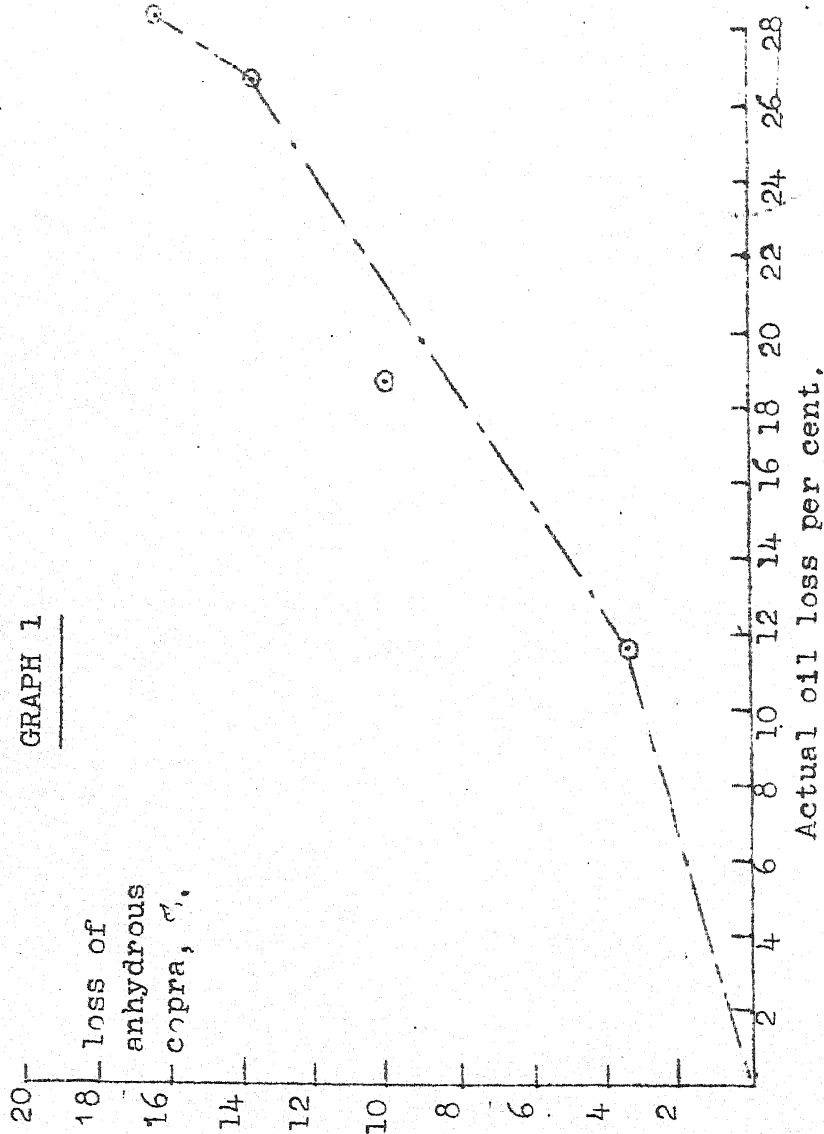
(1) With regard to (1) practical experience has definitely shown that drying-copra, on open "Vatas" unprotected from rain, becomes seriously infected with moulds especially if the humidity of the atmosphere limits the rate of drying. It is quite a common thing to notice that copra which under the influence of a spell of dry weather has developed the crackling sound on fracture, also a clean fracture, becomes quite leathery if the drying conditions are changed by a spell of very humid weather. This flacid condition is due to the absorption of moisture. If, as some authors go so far as to maintain, that mould action is definitely controlled by the amount of water present (see Copeland: "The Coconut") then a changing water content would have a marked effect on mould action. This, however, is only apparently so, since changing water content would also mean a greater solution and consequent ionisation of free fatty acid with the production of hydrogen-ions which in an unbuffered solution would mean an increasing actual acidity.

It is essential, in order to prevent or limit mould action, to dry the copra as rapidly as possible to somewhere in the neighbourhood of 5 per cent. at least and this is impossible under high humidity conditions on the open "Vata" with inadequate protection from weather. It might be argued here that rain falling on semi-dried copra has difficulty of penetration but it is to be remembered that superficially the water concentration would be high enough for mould activity and that this superficial concentration would be regulated by the humidity of the atmosphere.

(2) Experiments now being carried out have displayed the fact, as far as superficial examination is able to determine, that it is unusual to find under commercial conditions several moulds attacking copra with equal intensity at the one time. It appears more usual to find a preponderance of one growth and in many cases one growth only actively operating. The appearance of another seems to herald the decline of the actively operating type under observation. If, owing to peculiar conditions in different portions of the meat, several fungi have made their appearance, the growth of each is restricted and stunted.

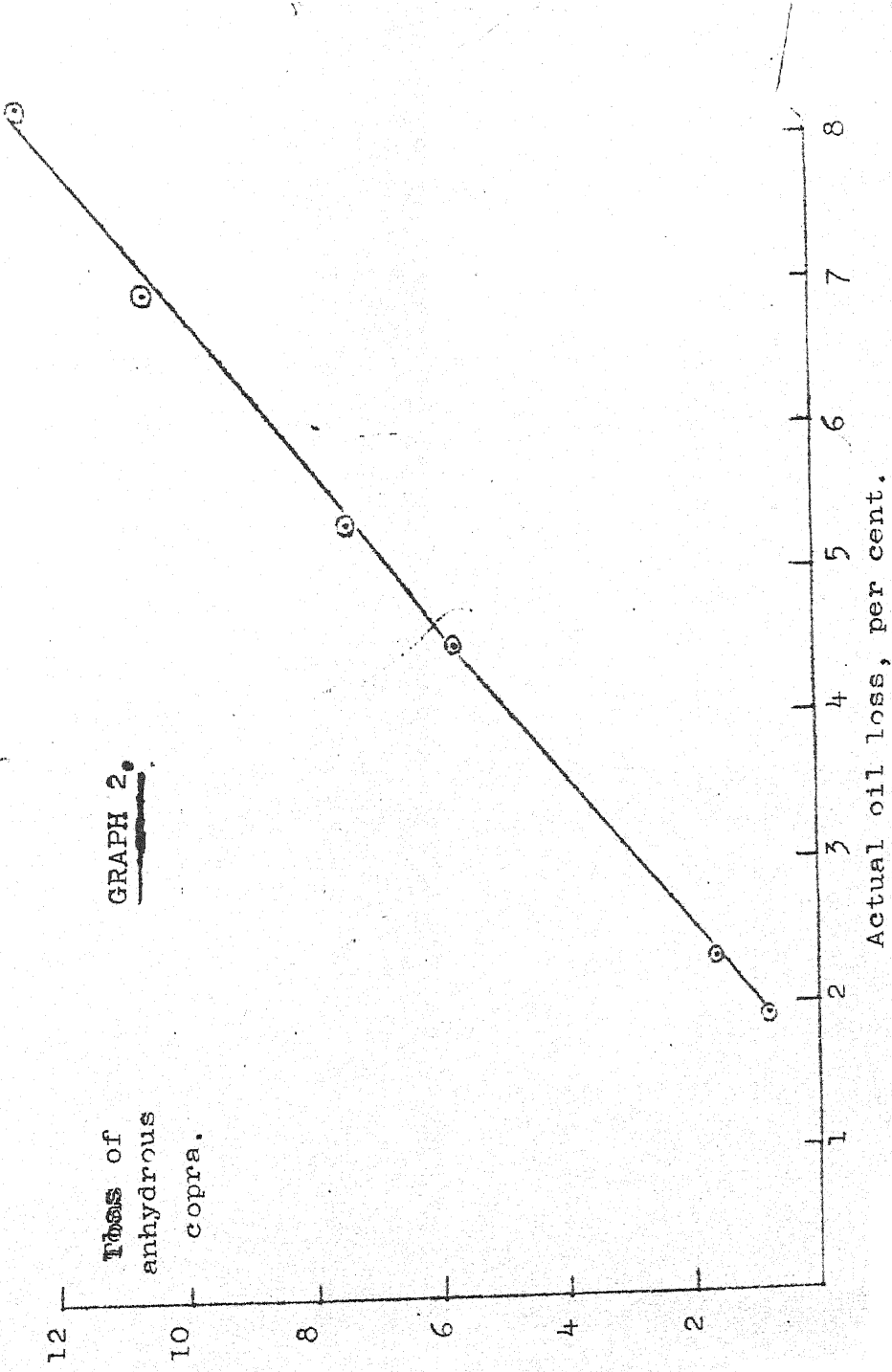
(3) If a careful observation is made of drying meat it is seen, during the first and second day under humid conditions, that a slight browning may take place in some cases. In others differences are noticed in the colour of the meat at definite positions on the surface although microscopic observation showed few spores and those that were present did not appear to be germinating. It would appear from this that the fungoid spores present could not develop until the surface had been changed in some manner for them. Further microscopic observations showed that when the spores developed they did so in these discoloured patches. The reason for considering bacteria as a precursor of fungoid action was stated in the introduction. It might be argued that experiment (1) negatives this surmise since infection of a fungoid on sterilised material resulted in the development of the fungoid growth. But it is to be remembered that the fungoid growth was not sterile with regard to bacteria and also that the material infected was already prepared copra and possibly had already, before sterilisation, been subjected to a preliminary bacterial infection, with an accumulation

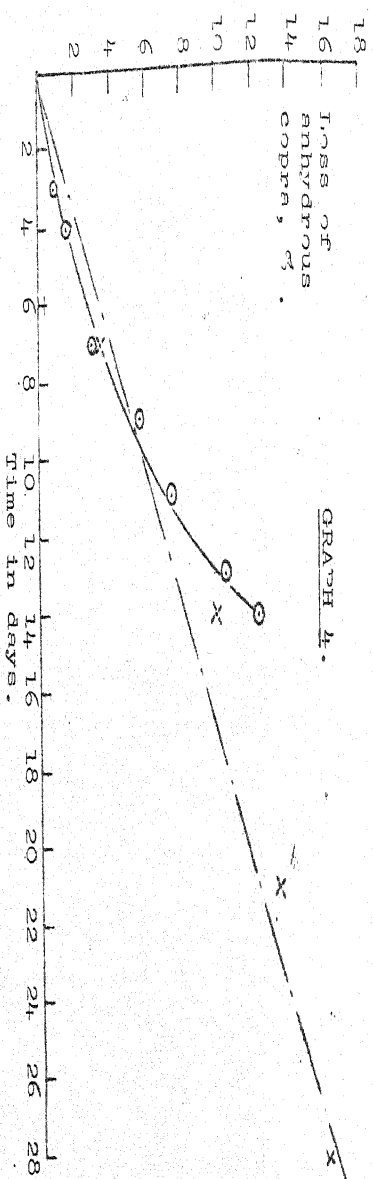
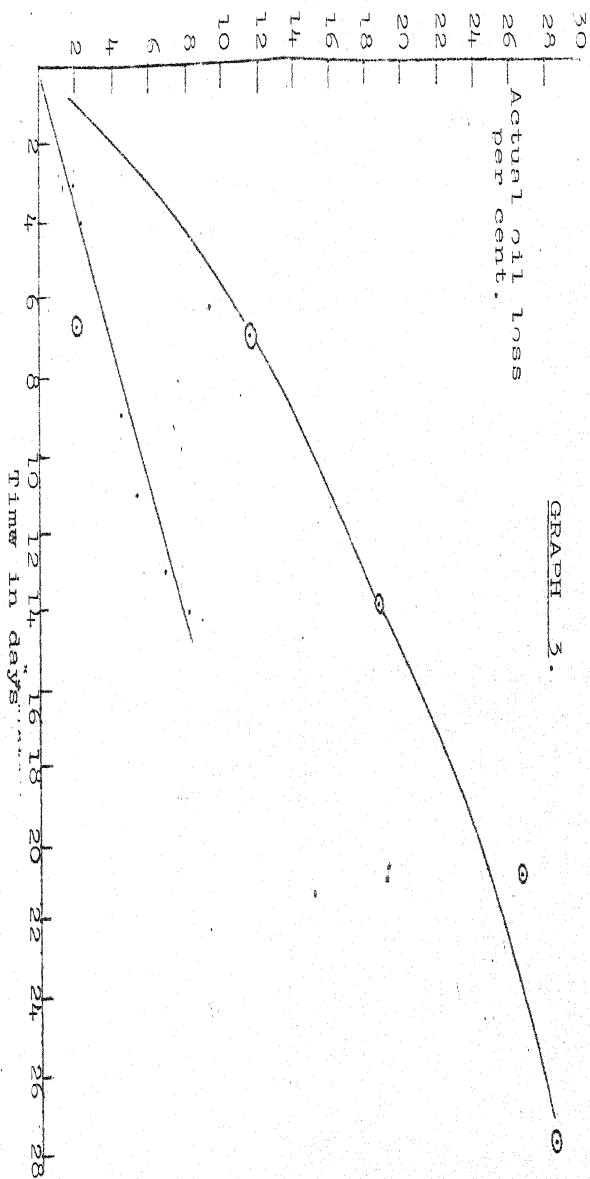
GRAPH 1



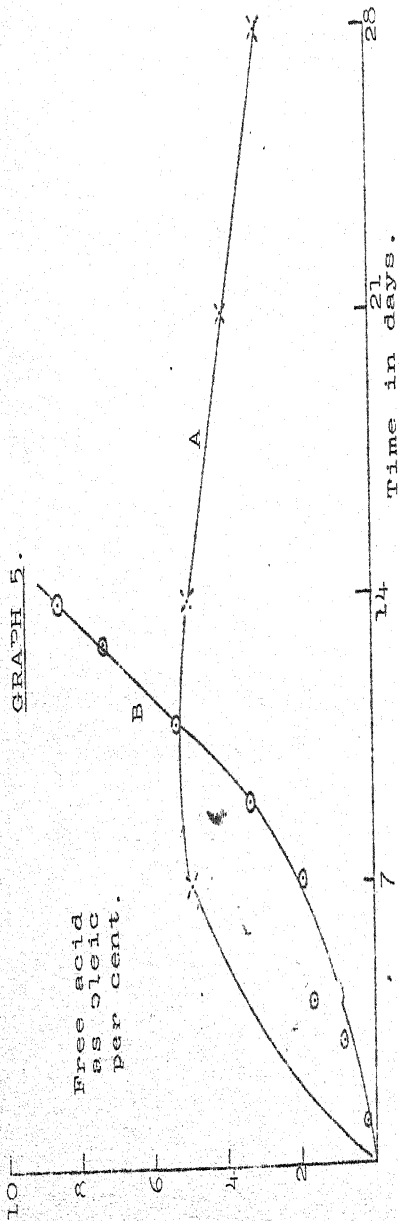
GRAPH 2.

Loss of
anhydrous
copra.

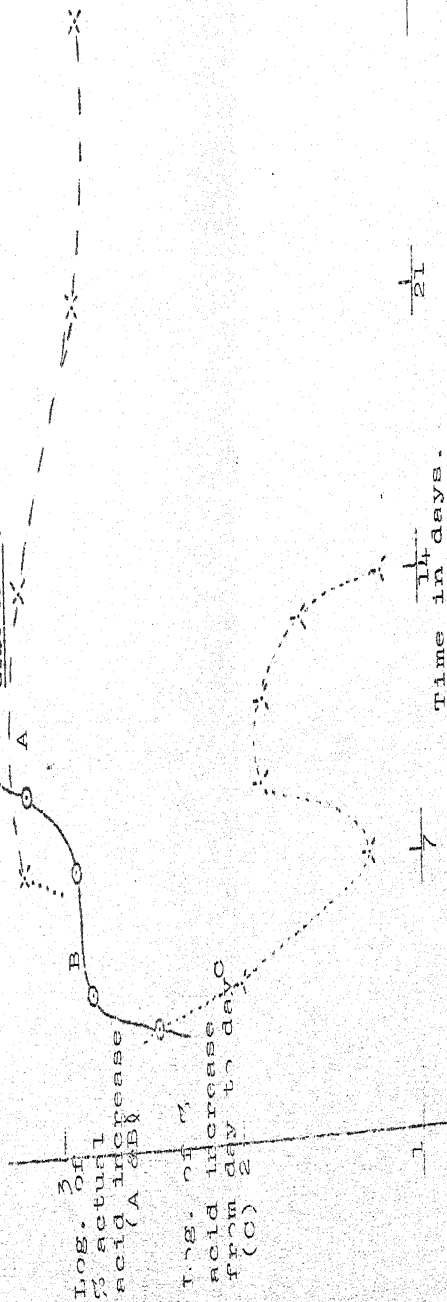




GRAPH 5.



GRAPH 6.



of products necessary for fungoid development. Instead of negating, experiment (1) tends to support the surmise from the following considerations. The control dishes, after sterilisation, were placed in the same cupboard and in close proximity to the dishes in which *Aspergillus* species was actively growing. Now these controls under the above-mentioned conditions did not change in oil and free fatty acid within the limits of experimental error during the period of the experiment (one month). It is conceivable that spores must have fallen on this control material and it is reasonable to ask why they did not develop. Apparently, the slight acidity 0.3 per cent. was detrimental to bacterial action or rather for the action of those types present in a chemical laboratory since the material remained sterile, (if sterility can be measured by an unchanged substrate) during the experimental period. The only conclusion to be drawn then is that suitable strains of bacteria or suitable products for germination were introduced with the infection on the experimental dishes. The former view seems more acceptable in the light of experiment (2). Here possibilities of obtaining the right strains of the bacteria would be more limited than under exposed conditions or by direct inoculation and it is to be noted that only a single fungus established itself and grew very slowly during the experiment. However, other limiting features are discussed in the results of the experiment. It will be realised how important the proving of this point would be in the control of growths since by suitably sterilising the material it might be possible to either limit the series of reactions or else prevent them entirely. Experiments are now in progress from these points of view.

(4) It is reasonable to suppose since the fats have a high concentration, in the copra and are in an available form that enzyme action would be concentrated on the splitting of these substances. This may be true but it is not correct to believe that enzyme action is limited to these substances. In this connection the following graphs (1) and (2) are interesting. The values used are taken from Tables 1 and 4.

If the destruction of copra is directly proportional to loss in oil then, if corresponding values of per cent. loss of anhydrous copra are plotted against per cent. actual oil loss then a straight line graph should result. On comparing the two graphs it is seen that this is true for the greater number of values in graph (2) and less accurately in graph (1) which suffers from lack of intermediate values. In both graphs it is to be noticed that in the preliminary stages enzyme action is not limited to the decomposition of the fats. It is noticed in graph (2) after the third day when the free acidity has reached the value of 0.8 and when 0.8 per cent. anhydrous copra has been lost that enzyme action appears to be limited to fat splitting. Graph (1) is not strictly comparable owing to reasons (discussed elsewhere) which may account for the slight irregularities. Again it is noticed in graph (3) that the loss of oil is heavier in the case of experiment (1) yet if the loss in anhydrous copra is compared under the same conditions, graph (4) it is seen that they are comparable up to almost the fourteenth day. This shows that copra is being changed at the same rate but that other enzyme besides the lipase group are actively operating and obscuring results.

(5) The reasons for considering this point as a feature in copra destruction was discussed in the introduction of this paper and no doubt is the main point concerned with the prolonged action of moulds permitting, as it does, attack from various species. Experiments now in the course of progress seem to show that by varying the hydrogen-ion concentration of the superficial medium growth is limited and in one particular experiment, greatly restricted. These experiments will form the subject of a further communication.

(6) On examining graph (3) it is noticed that the per cent. loss of oil as graphed against the time, shows a great difference in the two cases. In that case where only one fungus is grown the loss of oil is very much greater but begins to fall off between the 21st and 28th day. The same type of graph is displayed in both cases but the loss is more gradual with the copra prepared under commercial conditions. Many objections could be raised here from the points of view previously discussed in comparing these two experiments but observations of commercially made material seem to support this contention. From the graphs it is seen that the loss of oil is almost a function of the time that has elapsed up to at least twenty-one days in the case of experiment (1). Experiment (2) was discontinued at the 14th day.

(7) The production of acids in an unbuffered medium would have, in the presence of sufficient moisture, an effect on the hydrogen-ion concentration. This, of course, is qualified by the nature of the acids and their ionising ability. Therefore this section could be discussed under (6) above. In graph (5A) it is clearly shown that the acidity rises steeply then very gradually until, at the 14th day, it begins to decrease and at the 28th day it has a value corresponding to what it was between the 4th and 5th day (from the graph). This condition is not realised in graph B for copra prepared under commercial conditions. The rates of formation of acids is irregular up to the 7th day when the increase is regular to the 14th and is almost perfectly a function of the time. Peculiar features with regard to graphs A and B are that decreasing acidity (5A) does not correspond to increase oil or rather relatively decreasing oil loss nor does increased acidity (5B) correspond to markedly increasing oil loss.

Undoubtedly this phenomenon requires further confirmation. With regard to experiment (1) the nature of the graph would seem to indicate the point mentioned in the introduction that the disappearance of the free fatty acids points to the action of the enzyme carboxylase.

CONCLUSIONS.

When it is considered how varied are the uses of coconut oil both as a food source and in the soap and allied industries it is understood how essential it is to produce as pure an article as possible, both from the point of view of increased returns and also the cheapening of the manufactured article. If it is considered that the total production of copra in Fiji in 1926 was 27,868 tons and if all this suffered a deterioration from mould action of 12.4 per cent. then the loss to producers amounted to at least £70,974 at the then ruling price of £18 per ton. This loss would be even greater in the wetter districts of the Group. This is serious and attempts to remedy the condition are called for. In the foregoing some attempt has been made with the help of experimentally obtained values to discuss this problem with a view to controlling mould growth. This paper was written primarily to stimulate interest in the subject and also as an introduction to work now in progress in which practical attempts are being made to control this loss, notably by a thorough investigation of the claims made for sulphuring copra as a preventive of fungoid action. It is hoped that these investigations will be of use and of sufficient importance to merit further communications. No doubt many of the points raised and the methods of interpretation of results are controversial nevertheless there are certain grounds, if only tentative for the above discussion; and if interest is stimulated thereby then one of the objects in writing this paper has been satisfied. Undoubtedly a thorough mycological investigation is called for since this is a part of the subject that has been neglected.

Much useful work and investigation has been done in the Philippines on this subject but more is required; also conditions are not altogether similar in each country more especially with regard to the types of organisms attacking the copra and also climatic features.

Recently in the British Chemical Abstracts for March, 1930, page 375, several papers dealing with the action of *Aspergillus* species on synthetic media, &c., are discussed. In *Acta Phytochim* (1924, 4, 343-361) H. Tamiya and T. Hida discuss in a very important paper the acid production, respiration, oxidase reaction and reducing power of various species of *Aspergillus*. Unfortunately the original paper is not available and the abstract is rather short. In the (*J. Soc. Chem. Ind. Japan* 1929, 32, 306B, 307B, 308B) R. Takata considers among other interesting things the reaction between the hydrogen-ion concentration of the medium and the yield of mycelium and the influence of sodium chloride, sodium sulphate and sugar concentration on the growth of the mycelium. He finds:—

(1) that the maximum yield of mycelium is obtained between P.H. 4.5 and 5.6;

(2) that growth is increased by the addition of sodium chloride and sulphate to the medium in definite concentrations.

We have found that washing "meat" with a 5 to 10 per cent. salt solution with the idea of producing the white mould free copra sometimes obtained by drying the material exposed to sea breezes, produced on drying a very mouldy copra which was completely decomposed after two months storage in a sealed specimen bottle. Controls similarly stored although attacked slightly still yielded after the same time a fair quality copra. The complete decomposition of the material appeared to be due to the action of one mould. These results are interesting and again display the fact that the nature of the superficial medium controls the type of organism that can establish itself and develop.

I am indebted to Mr. Surridge, A.R.C.S. (1) Agronomist to the Coconut Committee, for valued criticism and suggestions.

ENTOMOLOGICAL NOTES.

(i) THE CLIDEMIA THRIPS (*LIOTHRIPS URICHI*, KARNY).

By H. W. SIMMONDS, F.E.S.

A STRONG colony of this insect was introduced from Trinidad, to be used against the Curse, *Clidemia hirta*. They landed in good order on 13th March and by the 20th, 5,000 adults had been picked off the plants and placed, half in cages for breeding purposes, and half in the open.

It is proposed to breed the insect up and liberate in the various districts as material becomes available. The effect of the insect is to cause a die-back of the terminal shoots, but not to kill the roots. When the insect is well established, planters will still have to clean their land, but it is hoped that it will so far reduce seeding that reinfestation will seldom take place.

THE LANTANA BUG (*TELEONEMIA LANTANÆ*, DIST.).

This bug, introduced in October, 1928, is now well established in the Suva District. Considerable areas show a yellowing of the foliage, combined with a failure to produce flowers or set seed, whilst in some places it has reached the extent of defoliating the plants.

(ii) BIOLOGICAL CONTROL OF SPATHE-BORER, COCONUT SCALE, AND KOSTER'S CURSE.

By T. H. C. TAYLOR, B.Sc.

The following notes, which are in the nature of an interim report, may be of interest to planters and others who are personally concerned with these pests.

1.—CONTROL OF *TIRATHABA TRICHOGRAMMA*—(SPATHE-BORER).

The parasite imported from Java in March, 1930, to combat *Tirathaba*, which is a serious pest of coconuts on every island throughout Fiji, is now being reared in large numbers in captivity. In Java this parasite attacks *Tirathaba rufivena* and *T. mundella*, two moths which are closely allied to the Fiji species, *T. trichogramma*. The latter species is not present in Java; nevertheless the parasite attacks it with avidity in Fiji.

The parasite is *Apanteles tirathabæ*, a small but very active wasp-like insect. It lays its eggs in young larvæ of *Tirathaba* and the resulting grubs feed on the internal organs of the larvæ and kill them after about ten days.

Many difficulties were experienced when the parasites were first imported into Fiji, chiefly owing to the necessity for quarantine for cholera, and the work of distribution has been greatly delayed in consequence. In the latter part of April, however, three colonies were liberated, one at Nasese, near Suva, chiefly for observation purposes, another at Muanicula, Wainunu, and a third in Taveuni, and it is thought that about four colonies will be available for liberation every month from May onwards.

The importation of this parasite, which was the result of the researches of Mr. Paine in Java, marks an important stage in the attempt which is being made to control *Tirathaba* in Fiji. The problem is not so simple as in the case of the Levuana Moth or of the Coconut Scale, both of which now appear to be satisfactorily controlled, but it is hoped that similar results will eventually be achieved in the case of *Tirathaba*. It may, however, be necessary to supplement the activities of the recently imported parasites by importing other species later in the year.

2.—*ASPIDIOTUS DESTRUCTOR*—(COCONUT SCALE).

A brief inspection of Muanicula Estate on the Wainunu River was made on 30th April, 1930. Large areas on this estate were very heavily infested with scale until 1928, when colonies of the Coccinellid beetle, *Cryptognatha nodiceps*, imported from Trinidad, were liberated. The beetles multiplied extraordinarily rapidly, and early in 1929 the infected coconut palms were all covered with them, so much so that the beetles and their larvæ could easily be seen from the ground on the leaves of the smaller trees.

The scale has now entirely disappeared from all parts of the Muanicula Estate and throughout the Wainunu district. Further, the beetles were liberated at about the same time in all parts of Fiji where scale formerly abounded, notably in the Lomaiviti Group and in the Savusavu district, and in all cases their liberation was followed within a year by the disappearance of the scale.

3.—*CLIDEMIA HIRTA*—(KOSTER'S CURSE).

Considerable progress has been made in connection with the distribution of the insects imported from Trinidad in the middle of March, 1930, to attack the weed, *Clidemia hirta*.

The insects in question belong to a peculiar group known as Thrips. Their technical name is *Liothrips urichi*, Karny. They are extremely small and are not readily seen with the naked eye. The adult insects are black and of an elongated, torpedo-like, shape. The immature stages are similar in shape to the adults but are bright red in colour, and therefore easily distinguishable from them.

The nature of the damage done to the plants is very apparent in the cages in Suva in which the thrips are being bred. The young leaves at the tips of the branches are attacked first. The insects live entirely on the undersides of the leaves and on the stems, and feed by puncturing the plant tissues, which turn black in the vicinity of each puncture. The resulting black spots are readily apparent on the plants. The attacked leaves and stems soon die and the leaves drop off. The plants are greatly weakened in consequence of the destruction of all the young shoots. In captivity the insects are capable of completely defoliating the plants and killing them outright.

Many large colonies of the thrips have already been liberated in the Tailevu district, and others at Nasinu and Lami. In Taveuni three colonies have been liberated, and one at Muanicula, Wainunu. Arrangements are being made to send infected plants to Navua at the beginning of May and others to the Rewa district soon afterwards.

In view of the widespread interest and optimism which have been shown in the activities of these insects it must be pointed out that in spite of their very satisfactory behaviour in captivity no immediate results can be expected on a large scale in the field. Moreover, the work must be regarded purely as an experiment, which is as likely to fail as to succeed. There is now little doubt that the thrips will become established in Fiji, but the areas in which *Clidemia hirta* flourishes are so vast that it will be many months if not years, before the insects multiply and distribute themselves sufficiently to bring about even a partial control of the weed. And at the present stage in the work it is impossible to predict whether they will ever effect an appreciable control.

PRESERVATION OF BOOKS IN THE TROPICS.

By W. J. BLACKIE, M.Sc., Government Chemist.

A GREAT deal of damage to books and documents results from the united action of insects and moulds. The worst insect offenders in Fiji are undoubtedly the beetle borer and the cockroach; these, by boring or gnawing the covers and printed pages, destroy the book both in appearance and usefulness.

2. In the Agricultural Department many valuable textbooks to which constant reference is being made, also many of the current journals, have been seriously attacked in the past and therefore our endeavours to build up a useful reference library is largely vitiated by the increased cost attending replacement of destroyed volumes. In many cases scientific papers of value, many of which are complimentary copies, cannot be so replaced.

3. In order to minimise this deterioration it is essential—

- (1) that the bookcases be closed by tightly-fitting glass doors;
- (2) that the air of the bookcases contain the vapour of some volatile chemical deterrent;
- (3) that the volumes themselves be treated with some poisonous material which, having no action on the books, prevents insect and mould destruction.

4. With these objects in view the following procedure has been adopted. Two solutions containing the following ingredients were made up:—

Solution (a) contained 1 oz. corrosive sublimate, $1\frac{1}{2}$ oz. carbolic acid and one-quart of methylated spirits containing pyridene as one of the denaturing agents.

Solution (b) contained 1 oz. of shellac dissolved in 8 ozs. of methylated spirits to which was added 3 drms. of creosote oil.

6. The books were first fumigated with hydrocyanic acid gas to kill spores, &c., then with a flat brush, solution (a) was painted on to the covers, inside and out, and generously along the seam dividing the cover from the printed material. After drying, which is quite rapid, the varnish (b) was painted on in a similar manner a slight smear being also added to the extremities of the pages, while the book was closed. On drying, the book has a varnished look which does not detract from its appearance. Solution (a) must be continually stirred during painting operations in order to obtain an even mixture of corrosive sublimate which has a tendency to settle out.

5. The shelves of the bookcase are also similarly treated with solutions (a) and (b), and after placing the books back in the case porcelain dishes containing paradichlorobenzene are added. A better procedure here would be to drill holes in the shelves at regular intervals and sink in suitable metallic containers for the paradichlorobenzene.

6. For facilitating storage and availability, scientific papers and pamphlets are kept in springback cardboard holders of the box variety. These are treated similarly by painting inside and outside with solutions (a) and (b) and an envelope containing paradichlorobenzene deposited conveniently inside or fixed with gum to the inside of the lid.

7. This would be a very convenient method for storing and preserving valuable Government documents and Minute Papers.

8. The above described procedure has been only recently adopted but the results attending the use of solution (b) by the Veterinary Department have been markedly successful.

9. With regard to frequency of treatment, little can be said as yet, however, once a year should be sufficient.

10. It is necessary to close the bookcase directly after removing or replacing a volume.

GRASSLAND ITS TREATMENT AND MANAGEMENT.

By R. LINDSAY ROBB, N.D.A., N.D.D., Imperial Chemical Industries Ltd.

PART I.—ESTABLISHMENT OF NEW PASTURES.

POINTS TO AVOID IN PASTURE ESTABLISHMENT.

THE most common causes of disappointment in pasture establishment are due to—

- (1) using seed mixtures unsuited to the local conditions;
- (2) sowing unsuitable strains of plants;
- (3) failure to rid the soil of excess moisture;
- (4) sowing seeds on weed infested land;
- (5) endeavouring to establish a pasture on land "worn out" by continuous cropping without manuring.

All pasture plants may be classified into groups or associations, and each association has a clearly defined set of conditions necessary for development. For successful establishment, therefore, an "association" must be sown to suit the local soil conditions.

The main consideration is the establishment of a sward composed of plants which may thrive under conditions as they exist. This, in all probability, is merely the foundational stage in the development of a future productive pasture and should only be regarded as such.

It is quite futile to attempt the formation of good pasture on water logged land, and money spent on seeds and manures is simply wasted until the excess moisture has been removed. Admittedly draining is a costly operation, but if land is water logged, the ever-recurring expense of seeding and manuring cannot be remunerative until the cause of the trouble—excess moisture—is removed.

CLEAN SEED BED.

The importance of clean land cannot be over-estimated in laying down land to grass. The weed competition may be serious enough for the first year or two on land which appears to be reasonably clean, but where conditions have not permitted of thorough cleaning prior to sowing the seeds, there is a very real danger of the weeds gaining the upper hand before the legitimate plants have been able to establish themselves. Land which may have been continually "white" cropped for a number of years without adequate manuring, always presents serious difficulties for good pasture establishment. The standard of fertility is low, and weeds adapted to this condition generally abound. Thorough cleaning and very generous manurial treatment are essential if a good pasture is to be obtained under such conditions.

VALUE OF SOWING PERSISTENT STRAINS.

Assuming that the land is clean and in good heart, it is important to secure strains of plants which are productive and highly persistent. The leaf is the richest and most nutritious part of the plant.

MANURING WHEN LAYING DOWN.

Liberal manuring of newly laid down pastures is highly important right from the earliest stages of development, and, where practiced, may permit of the establishment of high fertility demanding plants like perennial ryegrass and white clover under comparatively low standards of soil fertility. The importance of persistent strains of plants cannot be over-emphasised, as their response to and development by manurial applications is such, that the cost of manuring is relatively much less than on pastures comprised largely of short-lived and unresponsive plants.

PART II.—MAINTENANCE OF ESTABLISHED PASTURES.

SECONDARY GROWTH.

Large areas of grazing land in New Zealand are not giving of their best, because of the invasion of secondary growth. To effectively deal with this menace is extremely difficult, especially where the value of the land does not permit of much economic expenditure on labour and stock. The more extensive use of cattle to eat down the rank growth along with subdivision, and the use of suitable fertilizers to improve the quality of the herbage offers, perhaps, the most effective means of combating this difficulty.

DRAINING.

The need for removal of excess moisture has already been alluded to in Part I. There are, however, large areas of established pastures of comparatively low productivity because the land is in need of draining. Wet land encourages the growth of weeds and non-nutritious plants of an unpa-

latable nature; spring growth is delayed and grazing during the wetter part of the season is very difficult on account of the hoof damage done by the stock. Draining is often the means of converting this poor grazing land into highly productive pastures, and unfortunately, until this is done, the grazing value is almost negligible. The clearing of ditches and water furrowing in some cases will, to some extent, minimise the losses on poorly drained land. One of the most important features of drainage is to allow for heavier intermittent stocking to be carried out. The land, in an undrained condition is perhaps capable of producing an abundance of grass, but its utilisation becomes a matter of the greatest difficulty. Heavy stocking of wet land often results in the ruin of the pasture.

GRAZING AND MOWING.

While young pastures should not be too severely grazed in their early stages of development, the over-grazing of rapidly growing grass on established pastures, under high fertility conditions, is hardly possible, but may easily take place when fertility factors are not continuously high. The old method of leaving too much grass unconsumed during the late summer and autumn to supply winter grazing is not to be recommended, as the quality of the feed is extremely low and the rough grass suppresses and delays the new growth in spring.

Mixed grazing or grazing different types of stock over the paddocks keeps the pastures in better condition than grazing with one class of stock only. Horses are very selective in their grazing and the herbage soon becomes rough and tufted when they are the sole grazing stock. Sheep are also selective grazers, and confine themselves entirely to the short fine plants, whereas cattle are much less discriminating in their choice of the herbage plants.

As grass is nutritious in direct proportion as it is young, immature, and the product of rapid growth, the feeding of pastures when the herbage is short cannot be too strongly recommended, but this aspect of the question is more fully discussed later under intensive management.

If the stock cannot utilise all the grass, the mowing machine should be used to remove the surplus growth before any deterioration of the herbage takes place. By this means, the finer bottom grasses and clovers may develop freely when otherwise they may be suppressed almost to the point of extinction.

HARROWING.

The possibilities of effecting improvement in the pastures by more extensive use of the right type of harrows are very great. The chain harrow is useful for spreading animal droppings during the grazing season but quite ineffective as a cultivator. A severe tine harrow during the autumn or winter will assist in the removal of unconsumed grass or dead matter which may have accumulated, and will also improve the aeration of the soil. This greatly facilitates the action of any fertilisers which may be applied rendering them much more effective than if applied on rough unharrowed land. During recent years stronger and better types of harrows for grassland have been evolved and they are proving of great value throughout the grazing areas. The degree of severity of harrowing which is necessary will naturally vary according to the age of the pasture, the efficiency of past grazing, the amount of "dead" growth and condition of the turf.

CONSOLIDATION—HOOF CULTIVATION.

The improvement effected by the consolidation of grazing stock or "hoof cultivation" has often been very marked on grassland throughout

New Zealand. This has been specially noticeable on phosphatic topdressed pastures of the poorer types. The consolidation effected by the treading of the animals appear to facilitate root development of the herbage plants and finally produces a sward of pleasing density. An occasional rolling of the pastures is highly beneficial, but to be effective it must be done when conditions are suitable.

FENCING.

Proper and adequate fencing is a very substantial aid to the securing of maximum returns from grassland. Closer subdivision is urgently required on many areas in order that the grazing may be better controlled. When subdividing, it is advisable to fence, as far as possible, land of the same type. Various types of pasture in the same paddock are not conducive to efficient grazing. The question of fencing is more fully discussed in Part III.

LIMING.

Lime deficiency is one of the most serious limiting factors in the production of good grassland in the Dominion. Fortunately the practice of liming pastures is extending, but the rate could be greatly accelerated with advantage. Soil acidity and lack of lime, limits the species of pastures plants that thrive on any particular area. Further, those that thrive, are not so nutritious as they might be.

Even when lime does not materially increase the bulk of herbage on grassland, it usually beneficially influences the quality. The lack of response of many soils to phosphatic manuring is due to lack of lime. When there is no response of clovers to soluble phosphates, an application of lime should be tried. Even on limestone soils, a surface application of lime is often profitable, as the lime "in situ" may be too deep to sweeten the surface soil layers. Where intensive manuring is practised, liming should be carried out at suitable intervals. The effect of liming pastures reacts beneficially on the health of livestock. Ground carbonate is the popular form of lime to apply. The finer the grinding and the softer the lime, provided the analysis is high, the better. From 10 to 20 cwt. per acre of ground carbonate is a usual dressing, and the autumn and early winter is the best time to apply it. Limited pastures are more drought resistant than grassland which has not been limed, the clovers particularly and also the grasses making better growth during the dry period than on the unlimed area.

TOPDRESSING WITH PHOSPHATES.

Although in recent years there has been a big expansion in the topdressing of pasture lands with phosphatic manures, there is ample room for an extension of this commendable practice. New Zealand soils are short in phosphates, and there are few areas that do not repay an application of phosphatic manures. On many soils the stimulation of grasses, and particularly clovers, with a manure like superphosphate is indeed remarkable. Fortunately, not only is the quantity of herbage increased, but the quality is greatly improved. The better types of grasses thrive at the expense of the coarser species under topdressing, while the health of stock is generally improved, such complaints as bone-chewing being eliminated. From 2 to 3 cwts. per acre—in some districts twice a year—of superphosphate, is a popular dressing.

In certain districts, basic slag gives good results, and in recent years there has been an expansion in the use of Ground Rock Phosphates.

As to time of application, the tendency almost throughout New Zealand, but more particularly in the North Island, is to make the application of phosphates in March–April, so as to increase the autumn and early winter growth

of the pastures. A growing tendency also is to put on a second application in the spring. Where the summer rainfall is satisfactory, a late spring, or even early summer, application is being favoured nowadays to stimulate the growth of the pasture over the difficult December, January-February period. At this time of the year, a soluble phosphate, such as Super, is usually applied.

Topdressing with phosphates has been extended to the hill country, and, if the pastures of New Zealand are to be maintained in a profitable condition, the use of phosphates on grassland must continue to increase in intensity.

THE PLACE OF POTASH.

Potassic manures are annually growing in popularity in New Zealand. In some parts, such as Southland, their use has shown a very marked increase in recent years. Parts of the North Island, particularly peat swampy areas, *e.g.*, Taupiri in the Waikato, need potash also.

Intensive manurial trials, particularly under the new system of grassland management, will doubtless reveal many areas where potash manures can be profitably used in conjunction with other types of fertilizers. Light sandy and peaty soils are frequently deficient in potash.

Potash aids clover growth, and assists pasture plants in the dry periods. In some areas it is noticeable that stock more closely graze the parts of a pasture treated with potash.

The usual form for pasture is 30 per cent. potash salts and from one to two cwts. per acre can be applied.

PART III.—INTENSIVE MANAGEMENT OF GRASSLAND.

Grassland management has too long been regarded merely as a proposition of topdressing and the movement of stock.

It is not that these factors are in themselves unimportant, but they are hopelessly incomplete where maximum economic production is—or should be—the object in view.

The real aim in pasture management may be summed up briefly as the maximum production of herbage of the highest possible quality and its most complete utilization on the farm. This may be a difficult ideal to attain, but in a country like New Zealand where the chief raw material—and source of wealth—is grassland, it is an ideal which every farmer should keep constantly before him.

The main difficulties of the grassland farmer are, first of all, that he has more grass at certain periods of the year than his stock can consume, and secondly, too little at other periods to meet the stock requirements. The stock-carrying capacity of any farm is based on the number that can be carried during the lowest period of grass production, with the result that, during periods of abundance, the pastures are hopelessly undergrazed and the herbage rapidly deteriorates in quality.

New methods of pasture management known as the "New System" have been in operation in Great Britain and Western Europe for some years. This system has as its aim the ideals already referred to regarding production, quality and utilization of the herbage. It introduces several new features and may be regarded as a combination of the following:—

- (1) Complete balanced manuring.
- (2) Controlled rotational grazing.
- (3) Systematic cultural treatment.
- (4) Maximum conversion of herbage into animal products with all surplus made into ensilage and hay.

The system is based on sound scientific principles. Short young grass is richer in digestible protein and minerals and of higher feeding value than grass which has been allowed to grow long. By keeping the herbage consistently short and young, the high feeding value may be maintained throughout the whole season.

One of the vital factors of the system, therefore, is to maintain the pastures in their young and leafy state at all periods of the grazing season. This can only be done under a system of intermittent or rotational grazing and "spelling" and by the application of suitable fertilizers.

In order that the herbage may be utilised most effectively it must be consumed fairly quickly when it is very short as it will rapidly advance in growth to a less nutritious stage of lower protein and higher fibre content with decreased palatability. For efficient consumption of herbage relatively large numbers of stock are necessary on comparatively small areas, the stock being moved round the paddocks in rotation.

ROTATIONAL GRAZING.

It is clear that the adoption of intensive methods may necessitate a certain amount of subdivision of large areas into smaller paddocks and this is an important consideration, in view of the cost involved.

Control of grazing may, however, be regarded as the master factor in grassland management, and any expense incurred in the erection of fencing to secure this necessary control will be more than justified by the results. The size of a paddock under intensive management is really more a question of numbers of stock than actual acreage. The question of acreage is immaterial so long as the area to be grazed bears a proper relationship to the number of grazing animals. For New Zealand conditions it would appear that the relationship of land to stock (cattle) is twelve to fifteen cows per acre with a sufficient number of paddocks to form a complete grazing cycle.

Thus, on a dairy farm of 30 cows with a carrying capacity of one cow per acre, twelve two-and-a-half acre paddocks would be the ideal number. This, however, may be taken as a guiding figure and might have to be slightly modified according to special climatic conditions and composition of the pasture sward.

This question of size of paddock is of much greater significance than it appears on the surface because the principle of half the number twice as large having the same capacity as double the number half the size does not apply under intensive grazing. In other words, ten paddocks of three acres each have a greater stock-carrying capacity than the same area in five paddocks of six acres each. This has been shown conclusively on a number of farms by the increased grazing obtained after subdivision.

The grazing rotationally of small areas by relatively large numbers of stock necessitates frequent movement of the animals and this movement must take place before there is any decline in the milk yield. A three-acre paddock may carry 40 cows for two or three days, but a six-acre paddock will not carry the same stock for double this period because the wastage of herbage due to trampling, fouling, &c., is relatively higher in the larger paddocks.

It is important therefore, where any subdivision is contemplated, to keep closely in view the ultimate maximum stock-carrying capacity and arrange the size of the paddocks accordingly. For New Zealand conditions the number of cows divided by fifteen (intensive carrying capacity per acre) will usually give the acreage of the paddocks, e.g., 60/15 cow farm equals four acre paddocks.

If the stock-carrying capacity over the whole area was one cow per acre under a more or less continuous system of grazing, the fifteen-four acre paddocks here, under systematic rotational grazing, would provide in addition some ensilage and hay.

LAYOUT OF PADDOCKS.

The "layout" of paddocks for intensive management is important and the aim should be ease and economy of labour in moving the stock. The ideal arrangement is the double line of paddocks with a central "race" which should be of sufficient width to obviate any undue risk of "puddling" or "poaching" by the treading of the animals during wet weather. For reasons which are discussed later, it is advisable to have communicating gates between the different paddocks.

It is not advisable of course to subdivide the whole farm at once but to do so gradually as experience proves the value of the smaller areas and more effective control of the grazing. Thus by the time the whole or greater part of the farm is closely subdivided, the experience gained in the intensive management of a few small paddocks will be of inestimable value when the larger number are brought into the scheme.

WATER SUPPLY.

A supply of wholesome water is essential for grazing stock if the best results are to be obtained. Substantial economies can often be effected in the laying on of water by arranging any necessary subdivision to utilise existing supplies and making one trough suffice for two or more paddocks. Where natural supplies are unavailable an endeavour should be made to equip each paddock with water in order to facilitate the control of the grazing. Many pastures carry an inferior type of sward because they can only be grazed at certain periods when the stock can have access to water supplies.

THE PLACE OF NITROGEN IN MANURING OF GRASSLAND.

Owing to its frequent misuse in the past, nitrogen, until comparatively recently, was not regarded with favour as a fertilizer for grassland. The reason is not difficult to explain. Nitrogen is only one of many constituents which are essential for the growth of all farm crops, of which the most important in New Zealand is grass. There are, however, other constituents which are equally necessary for the growth of plants and the most important to the farmer, in addition to the nitrogen, are the phosphates, lime and potash. Nitrogen is, however, such a dominant factor in plant growth that if applied alone it will increase the yield of a crop.

Its continued application alone, however, over a period of years and the increased yields produced by its stimulation will ultimately give rise to a condition of soil in which one or more of the other essentials (phosphates, potash and lime) are so deficient that satisfactory growth becomes impossible. The strength of a chain always depends on the weakest link and so also does the yield of any crop depend on the essential for growth which is present in the smallest quantity.

BALANCED MANURING.

The fundamental principles of manuring are the maintenance of the balance of lime in the soil and the application of phosphates, potash and nitrogen in forms and quantities and at suitable periods which ensure maximum economic returns without any injurious effects to the soil.

It is clear therefore that nitrogen should not be used as the sole fertilizing ingredient, but in combination with phosphates, potash and lime, as

all four are being continually removed by the production of milk, meat, mutton and wool, and consequently all must be returned to the soil if fertility and high production are to be maintained.

It is not necessary, however, to apply phosphates, potash and lime at the same time as a dressing of nitrogen is given. As a matter of fact, it is often advisable to apply the mineral manures (phosphates, potash and lime) at different periods to that of nitrogen.

The application of nitrogen by itself must not be confused with applying nitrogen alone. Nitrogen alone means its application without phosphates, potash and lime, which is fundamentally wrong, but nitrogen by itself may be highly advantageous so long as the phosphates lime and potash have already been applied.

Phosphates, as already indicated, have played a wonderful part in improving the grasslands of New Zealand and in raising the standard of production.

THE ROLF OF NITROGEN.

Can nitrogen, in addition to the other necessary mineral manures, still further increase economic production in New Zealand? This question is of great importance to the Dominion farmers and the answer is being sought in the numerous manuring and grazing trials which are being conducted in New Zealand by the Department of Agriculture. From the work already done, there are indications that nitrogen, judiciously used, may become a factor of great importance in the economic development of the grasslands of this country.

IMPORTANCE OF EARLY SPRING GRASS.

Under existing conditions throughout the Dominion, the grass available during the months of August and September is generally insufficient to provide for full yields of milk, and in many cases it is largely utilised, not in the production of butter fat, but in building up the constitution of the cows. This is especially the case where the cows come down to calving in poor condition. For high production, early calving, constitutional fitness at time of calving, and ample grass supplies at the beginning of the lactation are essential conditions.

Early calving appears to be an essential condition to high butter fat production. The two opening months (August and September) probably constitutes the most important period in the whole lactation, and this period at present is one of comparatively low production. If cows are reasonably fit when they calve down at the end of July or beginning of August with plenty of grass available for full yields of milk, the total production per cow would be greatly increased. Better winter feeding is of course absolutely necessary if full yields are to be obtained from the beginning of the lactation.

From experience already gained in the more intensive management of grassland, it is perfectly clear that efficient control of the grazing leads to a complete elimination of pasture weeds. The fact that all herbage is consumed (or mown off) when it is short, prevents the seeding and consequent spreading of weed plants which tend to overrun many "continuously" grazed pastures at present. The beneficial results of this greater weed control are very significant as the legitimate plants have not only greater freedom for development, but also benefit from the extra food material in the soil which was formerly utilised by the weeds.

TIME OF APPLYING NITROGEN.

Because of its possibilities in increasing the growth of grass in August and September, nitrogen is likely to become a factor of great importance on the dairy farming of New Zealand. For this purpose, the indications are that it should be applied as a straight dressing during the month of June or early July after the necessary mineral manures have been applied. The month of July and early August is probably the period of the year when it is most difficult to induce growth because of the naturally unfavourable conditions. It is important, therefore, that the dressing of nitrogen given should be sufficient for the purpose required, and from experience already gained it would appear that from $1\frac{1}{2}$ to 2 cwts. per acre of sulphate of ammonia, or its equivalent in any other suitable nitrogenous manure is about the right amount at this stage.

It is difficult to lay down any hard and fast rules regarding the application of sulphate of ammonia for the purpose of securing an "early bite." The normal period of spring growth varies with different districts and it may even vary on different farms in the same district, depending on the soil and the composition of the pasture sward. For instance, on dry land, the spring growth is earlier than on land even in the same locality which becomes waterlogged during the winter months.

As a guide to the time of applying nitrogen, the following procedure may be of interest. If the spring growth of grass on a particular paddock normally occurs in early September and early grass is wanted by the beginning of August, sulphate of ammonia can be applied from the middle to the end of June. On the other hand, if the normal first growth occurs in October, an application of sulphate of ammonia may be applied with advantage in early August to bring forward the grazing to September.

It is clear that a small dressing applied when conditions for growth are unfavourable, may produce very little result, whereas the larger dressing suggested is likely to produce an excellent growth of grass when it is most difficult to secure and consequently of greatest value on the farm.

During the months of October, November and December, the natural rate of growth is sufficient to produce all the grass necessary without any artificial assistance, and the problem then is one more of utilisation than production.

In January and February there is generally a period of comparative scarcity of grass due to the rapid decline of growth through lack of moisture. How far can nitrogen, if at all, increase the grass growth during this period? A definite answer to this question cannot be given until further experimental work has been done. The limiting growth factor at this stage of the season is generally moisture supply, and the question of increasing the production of grass by manuring is more speculative than at other seasons of the year when the rainfall is more reliable.

CONTROLLED GRAZING.

One of the chief problems, and perhaps one of the greatest difficulties in the management of grassland, is that of controlling the grazing, and failure in this respect has been responsible for the ruin of many pastures. If the grass growth was more or less uniform throughout the season, the control of the grazing would be a comparatively easy matter, but unfortunately this is not the case, and of course, it is quite impracticable to vary the numbers of stock according to the amount of feed available at different periods of the grazing season.

The question of regulating the supplies of grass throughout the year, by increasing growth during periods of low production, has already been discussed, and there are certainly distinct possibilities in this direction. The higher the stock-carrying capacity can be raised during the winter and early spring months, the less difficult it becomes to control the wealth of feed produced during the "flush" period later in the season.

It is important that each paddock should be grazed bare in turn, as any grass left uneaten is not only lost from a grazing point of view, but it retards the continued development of fresh and succulent herbage. To facilitate clean grazing, the paddocks should be stocked when the grass is very short.

It is important to realise that, under intensive management, short young grass is a "green concentrate" rich in minerals, and should therefore be converted into animal products as far as possible. In other words, the wastage due to treading, fouling, &c., should be reduced to the minimum.

"ON" AND "OFF" METHOD OF GRAZING.

The ideal method of grazing is accomplished by moving the animals in such a way that the maximum use is made of the herbage with the minimum of trampling and fouling. After about one and a half hours' grazing in the morning, the dairy cow has consumed sufficient for her immediate requirements, and she then lies down to rest and ruminate. The wastage due to the cows lying on good grass is very considerable, apart from the fouling of the pasture when the animals rise again. They should therefore be moved on to a well grazed paddock just before they would lie down to rest. After mid-day, they would again go into the "feeding" paddock for an hour or so and then back again to the well grazed resting paddock. After the evening milking, they would again have an hour and a half to two hours in the "feeding" paddock prior to being moved to the resting (bare) paddock for the night.

This suggested system of grazing explains the need—referred to previously—for having communicating gates between the different paddocks. A certain amount of labour is of course involved in the carrying out of the "on and off" method of grazing, but the stock-carrying capacity is increased by the more efficient rationing of the feed, and hence its more complete utilisation. It is a system which should appeal to those who favour the "night" paddock, as any paddocks convenient to the milking shed may be used to serve as "resting" paddocks.

GRADING OF GRAZING STOCK.

Another method of grazing which is favoured is that of grading the stock into two lots according to their economic importance. On a dairy farm, the milking cows take precedence in the grazing scheme, and as soon as a paddock can no longer maintain the milk yield, they are moved on to a fresh one and their place taken by dry stock—uncalved cows, heifers, &c.—which follow up and complete the grazing. The light harrowing to spread the animal droppings during the season, should be done as frequently as necessary.

In this way, the paddocks are grazed and "spelled" in rotation, and while it is a great improvement on the old method of continuous grazing, it does not permit of the same degree of efficient rationing or so complete utilisation of the feed as the "on and off" method.

UTILISING SURPLUS GRASS.—ENSILAGE.

During periods of abundance of feed, the stock available may be incapable of utilising all the grass. These are critical periods of the grazing

season because failure to remove herbage not required by the stock will result in rapid deterioration of the pastures. The clovers and finer grasses become suppressed by the rapid-growing stronger species, and the result, after a period of bad management, is a rough "open" type of pasture with the ultimate elimination of the leguminous plants.

The obvious remedy is to remove the herbage before it reaches this stage and make it into ensilage or hay. By so doing a valuable foodstuff is conserved for use during periods of scarcity and the pasture remains in excellent condition.

In any case it is essential to make provision against possible prolonged droughts or other abnormal conditions, and the conversion of the surplus grass into ensilage is undoubtedly one of the best means of storing up this necessary reserve.

"CATCH" CROPS UNCERTAIN.

The growing of supplementary catch crops to provide "feed" during low periods of grass production is one of doubtful economy. The labour involved in the production of these crops is expensive and moreover they are seldom ready for use just when they are most required.

(From "Grassland, its Treatment and Management" by R. Lindsay Robb, N.D.A., N.D.D., Imperial Chemical Industries Ltd.)

NOXIOUS WEEDS.

By A. C. BARNES, F.I.C., B.Sc., A.M.I.Ch.E.,
Superintendent of Agriculture.

THE problem of controlling the growth of noxious weeds is increasing in importance. Agricultural operations in Fiji, whether conducted by Europeans, Fijians, or Indians, involve a continuous struggle to combat the inroads of such objectionable plants as Koster's Curse (*Clidemia hirta*), Lantana, and Prickly Solanum (*Solanum torvum*). Even on lands under continuous cultivation the menace is serious, but when pasture lands, and rich areas of undeveloped country are seen to be heavily infested with these plants, it cannot but be realised that an early and determined effort is necessary to secure some measure of control. For years it has been known that this question must be tackled in no uncertain manner, and though sporadic efforts have been made; though legislation has been resorted to; and much time and effort spent in various directions, still the areas covered by noxious weeds go on increasing.

Development of the dairying and stock-raising industries is being retarded and the costs of maintaining arable land in cultivation are increasing. Production is held in check and the agricultural community views with dismay the luxuriant growth of noxious weeds. The weeds flower, seed, and spread, practically unchecked by enemies of any kind whatsoever. Occasionally one sees patches of land where the careful work of years has rendered the weeds less obtrusive and in properly cultivated areas, particularly those cropped by the Colonial Sugar Refining Company Limited, and its tenants, they are perhaps of minor importance owing to the system of cane cultivation practised.

The noxious weed problem is by no means new in the Islands of the Pacific. Darwin in "The Voyage of H.M.S. 'Beagle,'" recorded the spread of imported guava in Tahiti to such an extent that it became an objectionable weed a century ago.

Much is expected from the importation of a thrips from Trinidad to control Koester's Curse. We must, however, patiently await the results of the trials, and even these, if successful can lead but to a retardation of the spread of the plant for some time, though we may reasonably hope for a diminution of its incidence in a few years. Doubtless biological control will be an important factor in checking the growth of this weed, but complete eradication is, it is feared, too much to anticipate.

Let us then ask ourselves what are the possible methods of controlling and reducing the incidence of the noxious weeds of Fiji? The following suggest themselves:—

- (1) Complete clearing followed by cultivation; applicable to land intended for periodical cropping.
- (2) Clearing, cultivation and grassing, with the periodical cutting by hand or machine of noxious weeds in the early stages of growth; as on pasture lands.
- (3) Biological control. This has yet to be tested and in any case is not likely to remove the obligation upon the land worker of initial clearing of weeds.
- (4) Prevention of seeding of weed plants by slashing before they flower on uncultivated lands not used for pasturage.
- (5) Suppression by use of cover crops of a beneficial kind.
- (6) The use of weed killers.

Experimental investigations are being carried out by the Department of Agriculture, but these need time to attain a stage when definite instructions in regard to any given local conditions can be given. There are, however, numerous planters and stockmen who have themselves dealt with the noxious weed problem on their land, in many cases with considerable success. These persons are now requested to record their experiences for the benefit of others. The matter is of such grave importance that it is felt that all who may have attempted to solve the problem for themselves whether successfully or otherwise, will readily state their experiences in the realisation that the menace must be co-operatively grappled with if it is to be combatted with success.

A questionnaire is attached for the guidance of those interested. It may be returned completed, or a brief statement forwarded instead. The object is to endeavour to evolve a cheap and effective means of controlling the various noxious weeds throughout the Colony. Climate and soil differ widely in the Group and methods applicable to one plant or one set of conditions may not be suited to others. Suggestions whether based on experience or not will be welcomed, as also will references to literature in the subject of weed control.

I confidently appeal for the assistance of the whole of the European agricultural community, in the first instance for the collection of information and later, when definite plans have been formulated, for a determined co-operative effort directed towards the control of noxious weeds. Any person who desires that his name be not published in connection with the information he supplies is assured that his wish will be respected.

Replies should be addressed to the Superintendent of Agriculture, Suva, and should be plainly marked "Noxious Weeds." They will be transmitted post free.

NOXIOUS WEED CONTROL—QUESTIONNAIRE.

1. Province.
2. District and name of property.
3. Area: Total acres—
 Under pasture.
 Arable.
 Hill.
 Swamp.
4. Crops grown.
5. Degree of infestation of noxious weeds. Give common names, and state whether dense, sparse, or negligible; type of land and nature of soils on which the weeds grow.
6. What method(s) do you adopt for—
 (a) clearing and cultivating land for periodical cropping?
 (b) clearing and cultivating for the establishment of pasture?
7. What is the cost per acre of the initial clearing of noxious weeds on your land? (Give names of weeds.)
8. How do you keep noxious weeds in check on?—
 (a) Arable land.
 (b) Pasture.
 (c) Unused areas.
9. What is the annual cost per acre incurred by controlling noxious weeds under heads 8 (a), (b) and (c)?
10. Are noxious weeds increasing or diminishing on your land and in your district?
 Mention names of weeds.
11. Have you observed any factors which encourage or discourage the spread of weeds? If so, please describe them.
12. Please state any methods based on experience or observation which in your opinion are suited to the control and eradication of particular noxious weeds?

Signed:

Date: 1930.

“ADCO” MANURE.

A Paper read by Mr. AUTON, at the General Meeting of the Agricultural Society of Trinidad and Tobago, 10th February, 1927.

THE soil is the essential medium for the production of crops and although some soils are naturally rich in potential resources there are few which can be cropped economically without the addition of manure. Hence a study of the material which must be added to the soil to increase or maintain its fertility is of the greatest importance to the cultivator.

From time immemorial the standard method of enriching the soil in all the countries has been by the use of stable manure or farmyard manure. With the extensive displacement of the animal by mechanical transport the supply of this type of manure has gradually diminished and growers are faced with the problem of finding a suitable substitute. In looking round for such a substitute it may be well to consider a moment what farmyard manure really is. It is, of course, the waste solid or liquid products of animals, mixed in most cases with a certain amount of litter used for bedding. Incidentally it may be stated that the litter is valuable for absorbing the liquid excreta, as without this the most valuable part of the waste pro-

ducts is frequently washed out and lost. The raw material from which these waste products are directly or indirectly derived is invariably vegetable matter, a cellulosic substance. The processes of digestion and assimilation of food in the animal system are promoted by ferments called enzymes and obviously if we can cause vegetable matter to undergo similar processes independent of the animal we are in a fair way to provide a substitute for farmyard manure. Not only so but the substitute will be better than the original.

In the case of the animal much of the most valuable constituents have been extracted to provide for the growth and energy of the animal. In the case of the substitute, however, the whole of the constituents will be present and, if the process is successful, in a readily assimilable form. Hence our aim must be to promote the decay of vegetable matter in such a manner that a product similar to farmyard manure is produced, but with all the most valuable constituents retained.

The value of plant tissue as a means of enriching soils with organic matter has long been recognised as shown by the fact that all up-to-date growers use every favourable opportunity of sowing catch-crops of a quick-growing nature and turning them in before the sowing of the next crop. This system of green manuring has been highly developed in certain districts and has resulted in the conversion of large tracts of sandy, barren soil into fertile areas. If it is worth while to grow crops to turn in for green manuring, it is surely worth while to conserve and turn into manure the large amount of waste vegetable matter which is available in such abundance on all plantations and estates.

Although it is known that the chief mineral and nitrogen requirements of a crop can be easily supplied by the application of chemical manures, experience shows that a plentiful supply of organic matter is indispensable for maintaining the fertility of soils. There is little doubt that the superiority of dung is due not so much to the mineral substance and nitrogen that it contains as to the organic, humus-forming material which forms its bulk. Plant nutrition is a much more complex matter than the mere provision or maintenance of the necessary elements, and it would appear that the chemical or bio-chemical changes which take place in the soil before food of plants is made available for absorption by the roots is largely dependent on its humus content.

Of the exact nature of humus little is known, and the term may be considered one of convenience rather than explanation. It is the black substance usually associated with a rich soil, and results from the decomposition of organic matter. Its influence as a fertiliser is mainly indirect, and may be considered conveniently under three headings, namely, physical, chemical and as a medium for soil bacteria.

As a physical agent the effect of humus is to improve the drainage and tilth of the soil. This increases to an enormous degree the area suitable for root action and may be illustrated by imagining the difference between an impervious lump of clay and the same intersected in every direction by innumerable channels through which roots, air and moisture may pass. Humus also helps the soil to retain moisture. For example experiments give the following results:—

100 lb of dry sand can hold 25 lb of water.

100 lb of dry clay can hold 50 lb of water.

100 lb of dry humus can hold 190 lb of water.

Humus is a non-conductor of heat, hence it fosters that equable soil temperature so desirable for steady growth.

Chemically humus acts probably as a catalytic agent; that is, it promotes chemical re-actions without apparently taking part in them. This type of action is quite common in chemical re-actions. For example the activity of some substances is increased many times when absorbed by charcoal and there can be little doubt that the same kind of re-action occurs in the soil. Besides this all decaying organic matter contains a considerable proportion of elements of direct, nutritive value as plant food. This cannot be disregarded, though it is proportionately less than in artificial manures.

Finally there is the question of soil bacteria importance in promoting certain chemical re-actions essential to soil fertility. These bacteria feed on the decaying vegetable matter which they help to break down and render available as food for plants. They can no more live in a soil without humus than human beings could live in a desert devoid of vegetation.

Having established the importance of humus as a fertilising agent it is necessary to inquire as to the natural supply of this substance in the soils with which we have to deal. The fibrous loams and parts which are the richest in humus are relatively small areas of the world's surface and even here deterioration starts from the moment cultivation begins and this is particularly rapid in the tropics where growth and decay are phenomenal. Every tropical planter can point to fields which once were fertile but which now are poor or abandoned and the amazing difference in the yield per unit or per area in highly cultivated plantations and those where cultivation is neglected is a striking example of the necessity of maintaining fertility. The centres of high fertility are gradually moving, whatever the crop, and the extensive use of artificials during the last fifty years has not checked this. That this loss of fertility can be avoided is shown by the manuring trials carried out at the Rothamsted Experimental Station on what is now the most famous wheat field in the world which produced its 75th crop in 1925. One crop in this field has received annually farmyard manure only, during whole period; other plots have been continuously manured with standard artificials and mixtures. A critical comparison of the records of these plots now reveals the fact that the only plot which shows no deterioration whatever is that which has received farmyard manure, thus it would appear that the only way to maintain fertility is by giving liberal dressings of humus-forming manure. The water-holding capacity of humus has already been noted, hence a soil with high humus content is an insurance against drought. Even a fertile soil without water becomes a desert as witness the changes from desert to highly productive areas in Egypt, Southern California and North-West India by the introduction of water. It is safe to say that the crops of the world are more dependent on water than nutrients in the soil and whilst rainfall is beyond human control we possess in humus the power to increase the water-holding capacity of any soil.

It is largely owing to a knowledge of these facts that the "Adco" process appeals to the thoughtful grower. It has been known to the public for a very short period, yet its fame is already world-wide. The Scientific discoveries on which it is based appeared unobtrusively in the scientific Press and notes regarding the process found their way into the agricultural journals. To-day manure is being produced by the Adco process in England, France, Spain, Canada, United States, West Indies, South and West Africa, New Zealand, Malaya, Australia, India, Ceylon, Japan, Rhodesia, and Mauritius while inquiries from all parts of the world increase daily. It has needed no advertising to achieve this success. It appealed immediately to all serious agriculturists for a very simple reason, it offered no novel, artificial fertiliser but simply farmyard manure the value of which every grower

understands. We call this manure synthetic farmyard manure or "Adco" manure because it is produced without the agency of animals.

Standard "Adco" is a fine powder which embodies late scientific discoveries. Its function is to create the ideal conditions which cause the useful bacteria to work and also to increase the amounts of plant nutrients in the finished manure. It is invaluable in the great grain growing districts where machinery is displacing the animal, and where large quantities of straw, maize stalks, &c., are available. It is ideal for the tropics where weeds and vegetation are plentiful and where fermentation is rapid. Dunging has never been sufficiently possible on the great plantations hitherto, but the "Adco" process now offers a simple and perfect means of accomplishing this. "Adco" manure is made by stacking and wetting any type of vegetable refuse layer by layer and mixing with it "Adco" powder until a pile about six feet high is completed. The stack should have a flat top so as to hold water, not shed it. After the stack has been built there is nothing to do but to keep it moist until it is well rotted and ready for use. The method of stacking the heaps depends to some extent on the type of material being treated and users of the process will soon gain experience as to the best methods. For the benefit of new users it may be helpful to describe more or less in detail the method of stacking a heap of material of say about five tons. It may at once be said that in the tropics a shallow trench about 2 feet deep is a decided advantage. For a heap of this weight about $7\frac{1}{2}$ cwt. of standard of "Adco" would be required. Estimate roughly the division of the material into 6 lots and arrange the first lot on a square base with about 7 yards side. Water through a rose or any convenient form of sprayer and when well wetted sprinkle as evenly as possible 1-6th of the "Adco." Sprinkle with a little water just sufficient to clean the top of the layer. Spread another layer and continue the process until the whole of the material is in position and partly wetted seeing that the last layer of "Adco" is covered with a few inches of refuse and well wetted. In a few days the stack should heat to at least 80° F.; when another 1,000 gallons of water may be applied, and repeat this at intervals of about three days until the whole stack has received 4,000 gallons of water in all. The temperature will gradually rise until a maximum of 180° is reached but under certain conditions this may be as long as three or four weeks. Thorough trampling of the heap as it is built up is desirable and care should be taken that the top of the stack should be left as level as possible and not more than 6 or 8 feet high, the object being to facilitate the taking up and holding of the natural rainfall. The manure should be ready for use in from three to six months, the exact time depending on the nature of the material treated and the state of decomposition required of the finished product. A well made Adco heap can be cut out easily with an ordinary spade. It cannot be too much emphasised that the question of moisture is a controlling factor in the success of the process and uniformity of moisture throughout the heap is absolutely essential. A heap which is uniformly moist and well trampled ferments steadily with an even temperature curve, whereas a heap loosely packed with unmoistured portions is liable to violent fluctuations of temperature and besides seriously affecting the physical condition of the heap, it must not be forgotten that if the temperature rises too high valuable constituents may be lost through volatilisation.

Where large quantities of "Adco" manure are to be made the provision of water is sometimes a serious problem and it is obvious that "Adco" stacks should be made near a water supply. Every advantage should be taken of local conditions, however, to meet this problem. For example weeds, grass,

cuttings and sandy vegetable trimmings contain about 90 per cent. of water in their fresh state. If left exposed to wind and sunshine even for a short time this content is reduced to 15 per cent. and the necessity is entailed of applying the balance artificially.

Further, such fresh material is richer in nutrients than dried or withered material and it is thus of double advantage to use the fresh material.

In an exposed position the windward side of the heap will dry out quickly and check the fermentation, hence a sheltered spot is to be preferred or, as an alternative, a bank of earth can be thrown up or any other improvised protection can be arranged. In the rainy season in tropical or sub-tropical countries with from 5 to 10 inches of rainfall per month for three consecutive months no additional water is required after the stack is made.

Practically all the refuse from English agriculture and horticulture has been successfully treated and almost every waste known in tropical agriculture has been tested. Some yield better manures than others but all appear to be amenable to treatment. Some idea of the diversity of raw material will be gained from the following list of the more important examples which have proved suitable. Straw, including wheat, barley, oats, and rice; banana leaves, pineapple leaves, maize stalks, tea prunings, wild grasses, including lusenke of Uganda, goura of Brazil, sudd of the Nile, neld of Rhodesia, Lallang of Malaya and rushes of England, sugar cane trash, rice husks, water hyacinth, coffee waste, gayule, a rubber waste of Mexico, bracken, hop vines, wild sunflower, and garden refuse of every description.

The cost of making "Adco" manure is naturally a business concern of the would-be user of the process. Since local conditions overseas vary so greatly it is difficult to give reliable estimates for the cost of making in different countries and for the wide range of materials which are available. On the basis that 1 ton of dry material of a proportionately greater weight of moist material will produce 3 tons of finished product, it will take 2 tons of Standard "Adco" to produce 100 tons of well-rotted synthetic farmyard manure. The present cost on the site may be taken at £14 10s. per ton thus it would cost to-day £29, plus labour costs on the spot to produce 100 tons of manure. Apart from actual cost, however, there is the advantage in "Adco" manure that it is more bulky than pen manure and 15 tons per acre is a good dressing, and has actually given better results than 20 tons of ordinary dung. Further on large estates the heaps can be spaced at convenient distances and thus save part of the cost of transport which would be entailed in moving dung purchased from an outside source.

Mr. C. A. Jones, Agronomist of the Ste. Madeleine Sugar Co., Ltd., stated that some years ago the Local Department of Agriculture tried an experiment to break down organic matter with the use of certain chemicals but that it was not entirely successful. This experiment, however, aroused a considerable amount of interest in the subject of increased output of pen manure on our estates and brought back to memory a letter received from Dr. Tempany, Director of Agriculture, Mauritius, in 1919, which was published in the *Agricultural News* describing a method used in Mauritius for producing pen manure in large quantities.

For the last few years the Ste. Madeleine Sugar Co. have been using a modification of the Mauritius method and by this means have increased their output of pen manure per head of stock very considerably. This modified method is quite simple and can be carried out in the ordinary pens found on sugar estates. The bedding instead of being thrown in the pens in its full length is passed through a cutter and the chopped up material is

spread evenly over the surface of the pen. Cattle then trample it down and their droppings supply the material required for breaking down the bedding. The pen manure produced per head of stock is in this way increased at least four-fold. The limiting factor being the amount of bedding that is available, as on most sugar estates the head of stock is ample.

The difficulty, however, on many estates is to get the manure out to all the fields. Many fields are situated at a distance from the railway or gravelled roads and for this reason it is often impossible to cart the manure from the pens to such fields in the wet season, the result being that in the past these fields have never been pen manured, consequently their fertility has been considerably lowered.

By the use of "Adco" it was hoped that fields so situated could be pen manured and it was with this object, mainly in view, that five trial heaps were laid down during the last year on the estates of the Ste. Madeleine Sugar Co.

Mr. Auton has given an account of the method used in setting up the heaps and Prof. Hardy has given the results of the chemical analyses of the resultant manure. At Mr. Auton's request, I have attempted to collect information as to the use of the manure, and taking the Union Hall heap as a typical example the following expenditure was incurred:—

<i>Labour.</i> —Cost of collecting trash in dry season setting, watering, turning and weighing of heaps ..	\$45.00
<i>Cost of "Adco."</i> —6 cwt. at £14 10s. per ton ..	20.88
Total cost	\$65 .88

The weight of the final manure made from 6 tons of trash and 6 cwt. of "Adco" was 21.6 tons. The cost therefore works out at slightly over \$3.00 per ton of manure.

The cost of making Mauritius pen manure is probably less than this and it cannot be claimed that the "Adco" process is cheap. Indeed pen manure by whatever process it is made is expensive but there is no efficient substitute for it and it is an expenditure that has to be faced. At Ste. Madeleine we make something like 30,000 tons annually and we are anxious to increase this to 50,000 tons. The money that used to be expended in the purchase of artificial manure is now being used in making more and more pen manure. We are getting convinced that "Adco" will have its place in the future routine work of our estates as one means of adding to the humus content of our soils.

Mr. T. I. Potter asked: "Will Mr. Auton kindly inform us whether the "Adco" preparation can be applied to coconut husks with the object of converting these into synthetic manure for coconut estates? I ask this question because a member, who was unable to be present to-day, and who owns a coconut plantation, is curious to know whether 'Adco' can be used for this purpose on coconut estates, where a very large quantity of husks is allowed to decay under the trees. I am also anxious to know this myself."

The Chairman remarked that he did not believe that coconut husks would respond readily to treatment with "Adco" owing to the large percentage of tannin in the fibre, which acted as a preservative or resistant, and consequently delayed decomposition.

Mr. Auton observed that he had not experimented with coconut refuse, therefore he could not readily answer the question.

Mr. Jos. de Verteuil made some observation detailing his experiments at Valsayn in prefacing which he referred to the question asked by Mr. Potter.

Department of Agriculture,
Port-of-Spain, 8th February, 1927.

SYNTHETIC PEN MANURE PREPARED AT "ENDEAVOUR" ESTATE, CHAGUANAS,
BY THE "ADCO" PROCESS.

Mr. Jos. de Verteuil, Agricultural Chemist of the Department of Agriculture, said that he had analysed Synthetic Pen Manure prepared at "Endeavour" Estate, Chaguanas, by the "Adco" Process with the following results:—

Dry grass, which had been cut two or three weeks previously, was used for making the heap.

Started 10th November, 1926.

Completed 16th November, 1926.

Put out in the field 1st to 4th February, 1927.

Heap 30 by 30 by $4\frac{1}{2}$ feet—sunk to 19 inches.

130 lb of "Adco" was spread over each layer, one foot thick, and last layer covered with 3 to 4 inches dry grass.

The first layer was properly trampled and thoroughly wetted, but no further watering was necessary as there were good rains whilst the heap was being built up.

Cost.

Cutting grass from field (about 5 acres)	\$9.85
Heading out grass	2.73
Carting 70 loads dry grass ($\frac{1}{4}$ to $\frac{1}{2}$ mile)	3.13
Building heap	3.28
Wetting heap after being built (3 times)	3.20
Cost of 520 lb "Adco" at \$71.34 per ton	16.56
	<hr/>
	\$38.75
Average weight of a load dry grass 225–250 lb ..	7 to 8 tons.
61 loads manure obtained (7 loads weighed on an average 800 lb each)	21 tons.
Cost of manure per ton	\$1.85

Analytical Results.

	Natural sample.	Dried at 100°C.
Water	77.38	—
*Organic and volatile matter .	15.76	69.67
†Mineral matter	6.86	30.33
	<hr/>	<hr/>
	100.00	100.00
	<hr/>	<hr/>
Containing	Per cent.	Per cent.
*Nitrogen	0.51	2.25
†Lime (CaO)	1.10	4.86
†Potassium oxide K ² O	0.26	1.15
†Phosphoric anhydrido P ² O ⁵ ..	0.81	2.69

Professor F. Hardy, of the Imperial College of Tropical Agriculture, said that he had tested a sample of Synthetic Pen Manure, which was prepared at the St. Augustine Experiment Station, from Dry Cane Trash and he obtained the following results:—

Thirty-three tons of trash were weighed and treated with 2 tons of the "Adco" reagent.

The analytical results compared with air-dried cane trash and pen manure, also prepared at the Experimental Station, are as follows:—

	" Adco " Manure. Per cent.	Pen Manure. Per cent.	Cane trash. Per cent.
Moisture	74.03	71.65	15.42
Organic matter	17.38	16.86	75.57
Ash	9.20	12.50	9.01
Nitrogen	0.57	0.58	0.95
Nitrogen calculated on dry material ..	2.14	1.97	0.98

Proceedings of the Agricultural Society of Trinidad and Tobago, Vol. XXVII Part 2.

FIJI LIVESTOCK RECORD ASSOCIATION.

MINUTES OF MEETING OF BOARD OF DIRECTORS HELD ON THE
10TH APRIL, 1930.

Present: Senior Veterinary Officer; Messrs. Kiss, Barber and Craig. The Senior Veterinary Officer presided in the absence of the Superintendent of Agriculture.

1. The minutes of the previous meeting of the Board were read and confirmed.

2. Accounts, as under, were passed for payment:—

Leighton Ltd.—Rubber Stamps	£0 9 9
Government Printer—Rules	1 7 6

3. The Chairman pointed out that under the Rules of the Association animals registered on account of each owner were required to be numbered consecutively either by fire-brand or by tattoo. He stated that many owners did not possess the facilities for the numbering of animals and suggested that the Association purchase either a set of brand numbers or a tattooing instrument. After discussion the Board directed that a tattooing instrument be purchased from the Association's funds.

4. The Chairman stated that a number of applications for registration had been received and that the animals would be inspected as soon as possible and the Herd Book opened.

COPRA PRICES

LETTER TO DIRECTOR, IMPERIAL INSTITUTE, LONDON.

Sir,

31st December, 1929.

I have the honour to request that you would be good enough to forward to me, periodically, records of comparative prices of the different grades of copra marketed in London and Hull, and if possible, those ruling in Hamburg, Rotterdam, Marseilles and Genoa.

2. The copra industry of Fiji is feeling the depression of prices somewhat keenly. I feel that very much lies in the direction of better organisation of the industry somewhat on the lines of the rationalisation methods talked of, and doubtless practiced in Europe during the recent two years or so.

3. The quality of South Sea copra leaves much to be desired, and the matter of suggesting certain improvements directed to the production of a better grade of copra is receiving my attention. I shall be grateful at a

later date for the co-operation of the Imperial Institute on the lines afforded Zanzibar during the tenure of my office there. The copy of the report on the four samples of Zanzibar copra examined at the Institute, and submitted to Brokers for their information, handed to me by Mr. Brown, has been of considerable use to me personally, and no doubt was welcomed by the Department in Zanzibar, as it gives more definite information regarding the relative prices of the grades of copra submitted than was hitherto available.

4. I shall be grateful for the expression of an opinion as to the main reasons for the continued fall in the market value of copra; whether prices have reached a stable level or whether they are likely to continue to fluctuate considerably in the near future. My own view is that the recent amalgamations of the largest consuming companies have cut down competition for vegetable oils to a great extent and thus contributed to a reduction in the market price of copra, as well as of other oil-bearing materials.

5. I realise that this is only one factor, but it nevertheless seems to me to be an important one, and it is necessary for the business of production to be so organised as to keep down production and marketing costs.

6. You might care to invoke the assistance of the Empire Marketing Board in this matter, which is of great importance to the Colony of Fiji.

I have, &c.,

A. C. BARNES,
Superintendent of Agriculture.

REPLY FROM DIRECTOR, IMPERIAL INSTITUTE, LONDON.

Imperial Institute,
London, S.W.7.

17th April, 1930.

Sir,

With reference to your letter No. 1405 29 of the 31st December last on the subject of copra prices, I shall be glad to send you periodically a list of the comparative prices of the different grades of copra marketed in Europe.

A table is enclosed, taken from the Copra Market Report issued by Messrs. L. M. Fischel & Co., giving the c.i.f. quotations for different grades of copra at the principal European ports on the 15th January, 19th February and 5th March, 1930. The London, Rotterdam and Hamburg c.i.f. quotations are identical, but the Marseilles values differ slightly and are given separately.

A copy of Messrs. Fischel & Co.'s report dated the 26th March is also enclosed. This includes notes on the market position, the c.i.f. quotations referred to above, and the principal daily spot prices fixed by the London Copra Association.

You do not indicate how frequently you would like to have such reports but it is proposed to send you a copy of Messrs. Fischel's report at the end of each month. I shall be glad to learn whether the information given in the report and the proposed interval of despatch will meet your requirements.

The Imperial Institute will be glad to assist in any possible way to promote the improvement of the copra produced in Fiji and to furnish reports, on the lines of that previously supplied to Zanzibar, on any samples which you may forward for examination.

With reference to your inquiry regarding the market value of copra, it is generally held in the trade that the following factors have contributed to the fall in price.

A large increase in the shipments of copra from the principal producing countries (exclusive of the South Seas and African supplies) occurred in 1928, during which year the total shipments from these sources were 30 per cent. (*i.e.*, about 200,000 tons) higher than the average for the three preceding years. The figures for 1929 indicate that this increase has been maintained.

During the same period there was also a considerable increase in the shipments of a number of other important oils and oilseeds including whale oil, which is now being largely used in the edible oil trade. Statistics giving the shipments of copra, palm kernels, groundnuts, soya beans, olive oil and whale oil during the last three years are enclosed. This increased production has tended to depress the prices of all oils and oilseeds, and the difficulty has been accentuated recently by a marked decline in the demand for feeding cake and meal. The latter is attributed chiefly to the excellent grain crops obtained last year in most European countries as a result of which large quantities of coarse grain have become available for feeding purposes.

It is also held that well-organised buying by the principal users of copra and dependent selling by producers have helped to lower the price. In this connection it is alleged that the formation of the Margarine Union has had an important effect as it is stated that the Union has established a single buying agency, thereby eliminating competition between its constituent firms, and is able by virtue of the large scale of its market operations to influence the price of copra and other oilseeds.

At present it is difficult to make any forecast as to the future position, especially in view of the general economic situation and the fall which has occurred in almost all commodity values. The whole question is however being kept in view here and, in this connection, your suggestion that the Empire Marketing Board might be consulted will be borne in mind.

The trade reviews on the Oil and Oilseed markets during 1929 have just been issued by Messrs. Faure Blattman & Co. and Messrs. Frank Fehr & Co. and copies of their remarks on copra and coconut oil are attached for your information.

HAROLD BROWN,
for Director (Lt.-Gen. Sir William Furse).

COPRA.

NOMINAL QUOTATIONS AT EUROPEAN PORTS, *c.i.f.* d/w, USUAL TERMS.

	15th January, 1930 January/February shipment.		19th February, 1930 February/March shipment.		5th March, 1930 March/April shipment.	
	Ports.*		Ports.*		Ports.*	
	Marseilles.		Marseilles.		Marseilles.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Malabar .. G.W.S.	24 7 6	24 7 6	23 12 6	23 12 6	22 15 0	22 15 0
Ceylon .. F.M.S.	24 2 6	24 2 6	23 7 6	23 7 6	22 7 6	22 7 6
Singapore .. F.M.S.	22 15 0	22 15 0	22 7 6	22 7 6	21 5 0	21 5 0
Straits .. F.M.	22 0 0	22 0 0	21 10 0	21 7 6	20 7 6	20 5 0
East Africa .. F.M.S.	21 15 0	21 15 0	21 10 0	21 7 6	20 7 6	20 5 0
Manila .. F.M.	21 10 0	21 10 0	21 0 0	21 0 0	19 12 6	19 12 6
Cebu .. F.M.S.	21 17 6	21 12 6	21 10 0	21 5 0	20 2 6	20 2 6
Macassar, &c. F.M.	21 10 0	21 10 0	21 0 0	21 0 0	20 0 0	19 17 6
Plantation Rabaul						
South Sea	21 17 6	21 12 6	21 12 6	21 7 6	20 7 6	19 17 6
South Sea .. F.M.S.	21 15 0	21 10 0	21 10 0	21 5 0	20 5 0	19 15 0

* London Rotterdam, Hamburg.

COPRA MARKET REPORT—26TH MARCH, 1930.

L. M. FISCHER & Co., LTD., 36 AND 37, MINING LANE, LONDON, E.C. 3.

We have to report an irregular market during the past week. At the opening a firm tone prevailed owing to a good demand from dealers for speculative grades, together with a better inquiry from consumers, and prices advanced 7/6 to 12/6 per ton. At the higher levels, however, buyers became more reserved and part of this improvement was soon lost, since when business has taken place at prices which have fluctuated within narrow limits, shippers generally have refrained from offering to any extent and at the close the tone is quiet but steady with quotations unchanged to 10/- higher than last week.

The Marseilles market opened firm and up to £20 10s. was reported paid for Kiln-dried South Sea Afloat, and £20 7s. 6d. for March/April shipment, with other grades on a parity. Following this, prices gave way about 5/- per ton and at the lower level a fair business is reported in most grades, with afloat parcels commanding a premium of 2/6 to 5/- per ton, according to the steamer's position. At the close nearest values may be given as £20 2s. 6d. for Kiln-dried South Sea, and £20 5s. for Mixed Dutch East Indies, March/April shipment.

There has been a moderate inquiry from Northern European ports although the business reported is small.

Nominal Quotations for April Shipment c.i.f. d/w Usual Terms.

			1930.		1929.	
			c.i.f. usual Ports.	c.i.f. Marseilles.	c.i.f. usual Ports.	c.i.f. Marseilles.
			£ s. d.	£ s. d.	£ s. d.	£ s. d.
Malabar	..	.. G.W.S.	23 0 0	23 0 0	24 10 0	24 10 0
Ceylon	..	.. F.M.S.	22 12 6	22 12 6	24 5 0	24 5 0
Singapore	..	.. F.M.S.	21 10 0	21 10 0	23 7 6	23 7 6
Straits	..	.. F.M.	20 10 0	20 10 0	22 15 0	22 10 0
East African	..	.. F.M.S.	20 7 6	20 10 0	22 10 0	22 10 0
Manila	..	.. F.M.	20 0 0	20 0 0	22 7 6	22 7 6
Cebu	..	.. F.M.S.	20 10 0	20 7 6	22 15 0	22 10 0
Macassar, &c.	..	.. F.M.	20 5 0	20 5 0	22 5 0	22 5 0
Plantation Rabaul South Sea	..	..	20 12 6	20 10 0	22 15 0	22 10 0
South Sea	..	.. F.M.S.	20 12 6	20 7 6	22 12 6	22 7 6

Principal Daily Spot Prices fixed by the London Copra Association, 21st March:—

London—basis bags—F.M.S. Ceylon, £22 7s. 6d.; West Indian, £21 12s. 6d.; F.M.S. Java, £21 10s.; F.M.S. Dutch East Indies, £21 7s. 6d.; Mixed Dutch East Indies, £20 7s. 6d.; F.M.S. Straits, £21 7s. 6d.; F.M. Straits, £20 10s.; F.M.S. Mozambique, £20 15s.; F.M.S. Philippine, £20 12s. 6d.; F.M. Philippine, £20 5s.; H.A.D., Plantation Rabaul, £20 17s. 6d.; F.M.S. Plantation Rabaul, £20 17s. 6d.; Plantation South Sea, £20 15s.; F.M.S. Samoa, £20 15s.; F.M.S. South Sea, £20 12s. 6d.

Liverpool, Antwerp, Germany, Holland same as London; Hull, 5/- extra.

STATISTICS OF THE TOTAL SHIPMENTS OF SOME OF THE PRINCIPAL OILSEEDS AND OF THE WORLD'S PRODUCTION OF OLIVE AND WHALE OIL, DURING 1927, 1928 AND 1929.

		COPRA AND COCONUT OIL.				
		1927	1928	1929		
<i>Copra.</i>		<i>tons.</i>	<i>tons.</i>	<i>tons.</i>		
Total shipments from the principal producing countries (exclusive of South Seas and African supplies).		676,481	866,317	900,908	Review of the Oil and Fat Markets, 1929, by Faure Blattman & Co. Particulars of shipments of Copra by L. M. Fischer & Co.	
		680,341	875,224	859,580		
<i>Coconut Oil.</i>						
Exports from principal producing countries.		199,000	221,000	(a)	Official figures.	

(a) The official figures so far available indicate that the total in 1929 should not be less than in 1928.

		PALM KERNELS.			
		1928	1929		
<i>Palm Kernels.</i>		<i>tons.</i>	<i>tons.</i>		
Total imports into principal European countries.		491,964	479,856	Faure Blattman & Co.	
		GROUNDNUTS.			
		1927	1928	1929	
<i>Shipments from</i>		<i>tons.</i>	<i>tons.</i>	<i>tons.</i>	
India—					
Groundnuts		474,882	748,603	816,379	Official figures.
Groundnut oil (gallons)		55,886	352,341	269,867	Do.
China—					
Unshelled		54,379	55,522	*	Do.
Shelled		91,724	46,261	*	Do.
Senegal		399,202	406,986	380,313†	Do.
Gambia		65,107	74,442	49,751‡	Do.
Nigeria		90,773	103,161	94,330‡	Do.

* Information not yet available.

† January–December 15th.

‡ January–September.

The official figures for the total production of unshelled groundnuts in India are 2,046,000 tons in 1926–27 and 2,657,000 tons in 1927–28.

The following figures of the total imports of groundnuts into the principal consuming countries are given by Messrs. Faure Blattman & Co.

		1927	1928	1929	
		<i>tons.</i>	<i>tons.</i>	<i>tons.</i>	
		1,249,378	1,605,926	1,747,834	
		SOYA BEANS AND OIL.			
		1926–27*	1927–28*	1928–29*	1929†
<i>Shipments from</i>		<i>tons.</i>	<i>tons.</i>	<i>tons.</i>	<i>tons.</i>
Manchuria—					
Soya beans	1,621,697	2,040,982	2,897,200	573,400	Faure Blattman & Co.
Soya oil	167,098	89,235	98,718	21,457	Do.

* 1st November to 31st October.

† November and December.

		OLIVE OIL.			
		1927	1928	1929	
		<i>tons.</i>	<i>tons.</i>	<i>tons.</i>	
World's production ..		965,000	718,000	1,007,000	Review of the Oilseed, Oil and Oil Cake Market by Frank Fehr & Co.
World's production ..		1,079,021	627,648	1,003,347	Faure Blattman & Co.
		WHALE OIL.			
		1927	1928	1929	
		<i>barrels.</i>	<i>barrels.</i>	<i>barrels.</i>	
World's production ..		1,220,415	1,356,308	1,861,877	Frank Fehr & Co.
		<i>tons.</i>	<i>tons.</i>	<i>tons.</i>	
Converted at rate of 6 barrels.		203,400	226,050	310,313	

EXTRACT FROM "REVIEW OF THE OIL AND FAT MARKETS, 1929."

(Published by Messrs. Faure Blattman & Co.).

COPRA AND COCONUT OIL.

Our forecast that 1929 would be a year of large copra supplies, and that the bulk of the surplus over previous years would be taken care of by the U.S.A. has proved correct. The total shipments for the year amounted to 900,908 tons against 866,317 tons last year, and the total copra imports into the U.S.A. for the year amounted to 253,543 tons against 221,172 tons in 1928. The total imports into the principal consuming countries were 1,115,909 tons during 1929 against 974,946 tons in the previous year. Generally speaking, the copra shipments were heavy during the first half of the year, but showed a considerable falling off towards the latter part, the most noticeable drop being in the exports from the Philippines.

The imports of copra and coconut oil into the U.S.A. for 1929 show a considerable increase over the previous year, the total quantity of copra calculated as oil and coconut oil combined imported during 1929 amounted to 349,060 tons in 1929 against 273,536 tons in 1928. Undoubtedly the U.S.A. imported in excess of their requirements in anticipation of a tariff being imposed which is borne out by the increase in stocks, which, for copra as oil and coconut oil combined, amounted to 89,307 tons on the 31st December, 1929, against 65,034 tons on the 31st December,

1928. The excess quantity was mainly bought at the beginning of the year when America sent over large orders for Straits copra. Early in the Summer, America ceased to compete for supplies of Straits copra, but entered the market again in December, when further heavy purchases were made.

The Philippine copra shipments show a considerable falling-off being only 167,145 tons against 218,921 tons in 1928, but this is largely accounted for by an increased quantity of Philippine copra being shipped to the U.S.A. in the form of coconut oil. The shipments of coconut oil from the Philippines to the U.S.A. amounted to 186,816 tons in 1929, against 136,344 tons in 1928.

On the whole, the tendency of the market has been downward, the lowest price being reached in June, when sun-dried Straits and sun-dried D.E.I. was actually sold at £20 5s. nett. When the market had reached this level, however, the U.S.A. once again bought heavily, with the result that a sharp reaction set in, until £23 12s. 6d. was reached in September. The market then became sluggish and with small fluctuations gradually receded to £22 10s., which was the value at the end of the year.

During the first half of the year copra was cheap when compared to other oilseeds but during the second half of the year the position was reversed, and copra was not affected by the general drop which took place.

The reports from the Dutch East Indies, the Philippines, Straits and Ceylon, all seem to indicate the probability of small supplies during the next few months, but there is no reason why there should not be an improvement later in the year.

There seems to be again a tendency to increase the production of coconut oil in the copra-growing countries, as is shown by the increase in the shipments from the Philippines, also from the D.E.I. and from Ceylon.

EXTRACT FROM "REVIEW OF THE OILSEED, OIL AND OIL CAKE MARKETS FOR 1929."

(Published by Messrs. Frank Fehr & Co.).

COPRA.

Production of copra has again increased during the year under review.

Total shipments, including those of "Other Dutch East Indies," were 918,340 tons for 1929, compared with 905,398 tons in 1928.

Shipments to the United Kingdom rose to 90,299 tons, compared with 61,901 tons for 1928.

German imports were also larger at 240,696 tons for 1929, against 197,597 tons in 1928.

French imports, which were 180,960 tons in 1928, also show an improvement, being 188,370 tons for 1929.

Holland also shows a slightly higher figure at 140,272 tons, against 137,078 tons.

Imports into the U.S.A. during 1929 stood at 254,880 tons, compared with 223,652 tons for the previous year. In connection with this it is also interesting to note that apart from larger imports of copra, the quantity of coconut oil taken by the U.S.A. during 1929 was 183,900 tons, compared with 129,750 tons in 1928.

Examining the export figures, we observe a decline in the shipments of Manila copra, being 178,018 tons for 1929, against 201,000 tons for 1928. This difference, however, is well replaced by the larger shipments of coconut oil.

On the other hand shipments from the Dutch East Indies were more liberal, being 452,757 tons, compared with 436,493 tons for 1928.

The same refers to exports from the Straits Settlements, which rose to 186,112 tons, against 173,555 tons; while Ceylon shipments were also higher at 101,453 tons, against 94,250 tons.

There was a slight increase in the shipments of Ceylon and Java coconut oil during 1929. Ceylon exported 41,523 tons compared with 36,056 tons for the previous year, and Java 34,433 tons, against 33,537 tons.

The average price of F.M.S. Singapore copra c.i.f. London, during 1929 was £23 1s. 3d., compared with £26 7s. 6d. for 1928 and £27 7s. 6d. in 1927. The average price for 1929 was the lowest for recent years.

We started the year at £24 7s. 6d. in January, which price with minor fluctuations was maintained during February. In March we fell to £23 5s. and by June we were down to £21. In July prices improved to £23 6s. 3d. This higher level of prices was maintained during August and September, the average during the latter month being £24 1s. 3d. As shipments became more liberal and demand for cake decreased, the copra market followed the decline in the markets of other oilseeds and at the end of the year we saw the price down again to £22 12s. 6d.

It will be observed, however, that the decline in the price of copra since the turn of the year has been in no way as drastic as that of other oilseeds. The lowest price we have seen for copra was £20 17s. 6d. on the 7th March, 1930. During the same period the price of palm kernels fell to £14 5s. for float parcels, and that of Coromandel groundnuts to £15. The explanation of this can be found in the fact that at a low level of prices for cakes, the crushers naturally give preference to oilseeds containing the highest percentage of oil, or to copra "par excellence."

COCONUT OIL.

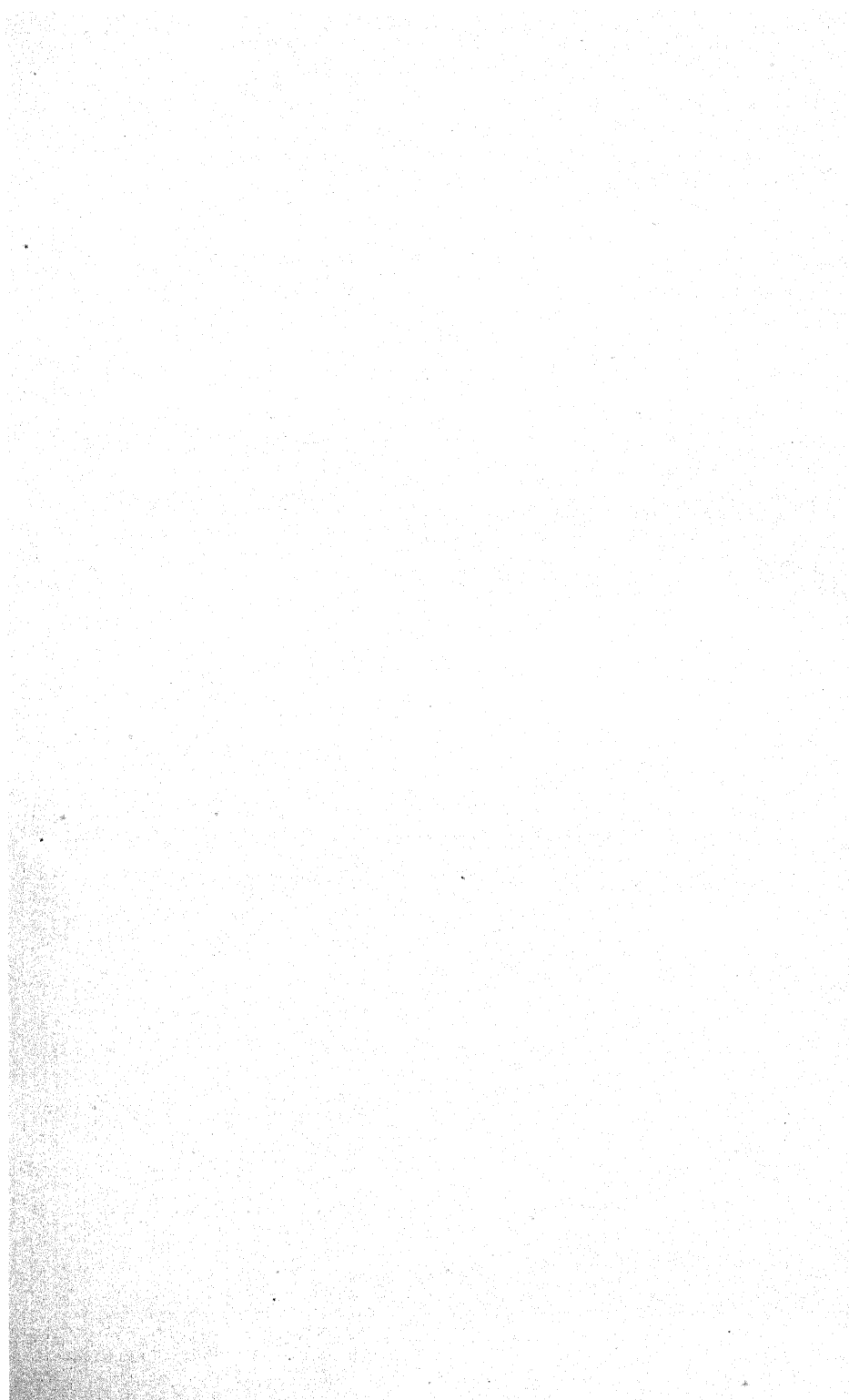
Manila.—During 1927 and 1928 the market for Manila coconut oil in America fluctuated between $8\frac{1}{2}$ and $8\frac{3}{4}$ cents per lb, c.i.f. New York, but in 1929 there was a wider movement. In January the average price in New York was $8\frac{1}{8}$ cents per lb. In August it fell to $6\frac{3}{4}$ cents, and closed in December at 7 cents per lb. It is interesting to observe the large increase in the imports of Manila coconut oil into the U.S.A., which rose from 129,750 tons for 1928 to the enormous figure of 183,900 tons during 1929.

Ceylon.—There is a further increase in the shipments of Ceylon coconut oil, which were 41,523 tons during 1929, against 36,056 tons in 1928 and 30,255 tons for 1927. In our last report we mentioned the gradual decline in prices of £4 to £5 per ton. A similar decline took place during 1929, so that compared with values ruling during 1927, the price of Ceylon coconut oil shows a fall of, approximately, £10 per ton. The United Kingdom and Italy were again the principal buyers of this commodity.

Java.—Shipments from Java show a small increase, being 34,433 tons in 1929, compared with 33,575 tons in 1928.

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE
DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 3.]

THIRD QUARTER, 1930.

[No. 3.]

EDITORIAL.

NOXIOUS WEEDS.

IN this issue will be found the first part of an article on the subject of Noxious Weeds and their Control in Fiji, which summarises the replies to the Questionnaire issued by the Department of Agriculture in March of this year. This subject will be discussed at the Agricultural Convention to be held in Suva at the time of the Fiji Show in October and a further article will be published in a later issue of the *Journal*.

Approval has been given for investigations to be conducted in Trinidad on the insects found by Mr. Simmonds to exercise some control on *Clidemia hirta* in that Island. Readers will remember he called attention to insect agencies other than Thrips which were found by him to attack the seeds and thus check the spread of the plant.

Attention has been called to the increased occurrence of a weed locally known as "Wild Verbena," "Purple Top" or "Purple Weed" (*Verbena bonariensis*) on land in the Wainimala River district. It is recommended that this weed should be pulled out and destroyed wherever it is seen.

Experimental work with sodium chlorate as a spray is being continued at Nasinu. As far as can be ascertained at present *Clidemia hirta* is affected to a greater extent than most of the other weeds, but whether or not it is killed completely remains to be seen. The spray appears to exercise a selective action on the different weeds, some of which are affected much more seriously than others. Lantana, curiously enough, appears to recover completely from the effects after a time, as also does Blue Rat Tail.

COPRA DRIERS.

The Coconut Committee has authorised expenditure on the erection of an inclined chamber copra drier to deal with native copra in a district easily accessible from Suva and plans and specifications are now in course of preparation. Several types of copra driers are in operation in Fiji and these will be made the subject of an investigation in the near future, with the object of evolving a standard type. The design approved for the one to be erected by the Coconut Committee appears to be the best of those hitherto investigated. The drier will be erected in such a manner that minor modifications can be easily effected.

RHINOCEROS BEETLE.

This serious pest of coconuts is increasing rapidly in Western Samoa, owing mainly to the breakdown in the beetle control formerly exercised in that territory. The danger of introducing the beetle to Fiji is thus increased and the matter of instituting more effective preventive measures is under consideration.

NOXIOUS WEEDS AND THEIR CONTROL IN FIJI.

By A. C. BARNES, Director of Agriculture.

PART I.

IN March, 1930, a Circular Letter and *Questionnaire was issued by the Department of Agriculture calling for information regarding noxious weeds in the different provinces of the Colony. Thirty-seven replies were received from the following provinces:—Ba, Bua, Cakaudrove, Kadavu, Lomaiviti, Lautoka, Lau, Macuata, Naitasiri, Nadroga, Nadi, Rewa, Ra and Tailevu. On the whole the response has been good and it is now possible to summarise the position in regard to this serious aspect of local agriculture.

Attention should be called in the first instance to the fact that plants of economic value in certain provinces and for certain agricultural pursuits are regarded as noxious in others. Thus, for example, one may mention Johnson Grass (*Sorghum halepense*, Pers.); Guinea Grass (*Panicum maximum*, Jacq.); Sensitive Grass (*Mimosa pudica*) and Para Grass (*Brachiaria mutica*, Stapf.) are welcomed on pasture land, but are a nuisance in cultivated areas, particularly in the cane districts.

It is difficult from the information at present available to decide in what order of importance the plants regarded as noxious weeds should be set out, for the reason already given and for other reasons dependent on the nature of the soil, climate, rainfall and agricultural pursuits followed in the various provinces.

The following list of plants regarded as noxious weeds has been compiled from the replies received:—

Johnson Grass ..	..	<i>Sorghum halepense</i> , Pers.
Nut Grass ..	..	<i>Cyperus rotundus</i> , L.
Guinea Grass ..	..	<i>Panicum maximum</i> , Jacq.
Prickly Solanum ..	..	<i>Solanum torvum</i> , Sw.
Guava ..	..	<i>Psidium Guayana</i> , L.
Ellington Curse ..	..	<i>Acacia farnesiana</i> .
Vaivai ..	..	<i>Leucaena glauca</i> , Benth.
Monkey Pod ..	..	<i>Pithecolobium dulce</i> , Benth.
Noogoora Burr ..	..	<i>Xanthium chinense</i> , Mill.
Fern ..	..
Koster's Curse ..	..	<i>Clidemia hirta</i> .
Lantana ..	..	<i>Lantana camara</i> , L.
Blue Rat Tail ..	..	<i>Stachytarpetta indica</i> .
Thurston Grass..	..	
Burr (unnamed)	..	
Sensitive Grass ..	..	<i>Mimosa pudica</i> .
Para Grass ..	..	<i>Brachiaria mutica</i> , Stapf.
Mile-a-minute ..	..	<i>Mikania scandens</i> , Willd.
Chinese Burr ..	..	<i>Triumfetta rhomboidea</i> , Jacq.
		<i>Ipomoea coccinea</i> , L.
		<i>Ipomoea quamoclit</i> , L.
		<i>Ipomoea quinquefolia</i> , Griseb.
Kaumoce ..	..	<i>Cassia tora</i> , L.
Burr Grass ..	..	<i>Cenchrus echinatus</i>
Blue Flower (Sigatoka) ..	..	<i>Eleophantis scaber</i> .
Seed Grass ..	..

* *Agricultural Journal*, Vol. 3, No. 2, 1930.

It will be convenient to consider the question as it affects the different provinces from which replies have been received.

BA PROVINCE.

The only reply received was from the Manager of the Colonial Sugar Refining Company, Limited, at Rarawai, who naturally dealt with the question from the point of view of the cultivator of sugar cane. He gives the following list of weeds occurring in his district:—In Ba-Tavua district—Johnson Grass, Nut Grass, Guinea Grass, Prickly Solanum, Guava, Ellington Curse and Vaivai; on Yaqara Estate—Monkey Pod, Ellington Curse, Guava and Noogoora Burr.

He states:—

Johnson Grass has proved the worst menace in our cultivated lands; it is found in both rich and poorer soils in the Ba District, and is spread in the droppings of stock and also by cane trucks, the seed adhering to oil and grease about the axle boxes. It is kept partially in check in fallow lands by such cover crops as Black Mauritius Bean and Rice Bean, but becomes abundantly evident again after these crops are ploughed under. It adds very considerably to the cost of cultivating sugar cane, entailing hand weeding at frequent intervals during the first six months growth.

The spread of Johnson Grass into our cane areas at Tavua has been prevented by the employment, practically ever since cane growing was started there, of some men whose sole duty is to search for, and eradicate, the grass along the tramlines and in other likely places throughout those areas. This has meant a constant expenditure, but has, without doubt, obviated a general increase in cultivation costs, entailing far greater expense throughout the Tavua District.

Under our conditions of farming, relief from the expense involved in combating Johnson Grass can scarcely be expected unless some method of biological control can be devised.

Nut Grass, although not as serious a pest as Johnson Grass, grows densely in many of our rich river flat areas. Unless kept in check, it seriously effects the "striking" and early growth of sugar cane. In very heavily infested fields, hand weeding at short intervals is necessary until the cane is about two months old. Nut Grass is infested in Fiji by a coccid which is to be found on the shoots at the ground level, and this insect, no doubt, exerts a partial control on its spread.

Guinea Grass is easier to deal with than Johnson Grass, but its eradication can entail heavy expenditure if it is not kept under control. It is spread largely by stock and in the oil and grease on cane truck axle boxes. Eradication must be carried out by digging out and destroying the stools.

Prickly Solanum is assuming menacing proportions in some of our areas along the Ba River. It appears to be spread by the agency of "bulbuls"; it is dealt with by uprooting.

Guava is a pest in land, chiefly on hill slopes, not under cultivation. We are gradually taking some of this land, where practicable, into cultivation by uprooting the Guava prior to ploughing. This is an expensive operation and is best carried out with the aid of tractors.

Ellington Curse is found on land not under cultivation. It appears to be increasingly evident in Ba-Tavua areas, and is dealt with by uprooting.

Vaivai is somewhat troublesome on rich river flats. It encroaches rapidly on the cultivated land and has to be eradicated.

Yaqara Estate.—On this estate, Monkey Pod, Ellington Curse, Guava and Noogoora Burr are all dealt with by uprooting, and where practicable, burning. The area under these pests is being materially reduced each year.

We trust this information will be of assistance to you. It will be observed that two grasses are mentioned which in pasture country would be of value, but in cane country can be a serious nuisance.

BUA PROVINCE.

Four replies were received. The principal crop is coconuts. Noxious weeds mentioned are Koster's Curse, Lantana, Blue Rat Tail, Guava, Fern, and Solanum. Methods adopted are—

(a) general clearing;

(b) uprooting of individual plants and burning.

In virgin areas it is said that practically no noxious weeds are found. The cost of clearing for cultivation is estimated at from 10s. to £3 or more per acre. Weeds are kept in check on rich land by annual cutting at a cost of upward of £1 per acre. It is stated that the annual cost of main-

taining grazing areas reasonably free from weeds is £1 on good land and 10s. on poor hills. The ravages of uncontrolled animals appear to assist the spread of weeds. One writer states that a reduction in the number of birds would tend to check the spread of weeds. The methods adopted for keeping land free from noxious weeds are clearing and planting with cover crops, such as Rice Bean and Mauritius Bean. One suggestion is that a Local Noxious Weed Board should be formed of landholders with the District Commissioner as Chairman to initiate and carry on campaigns in the different districts for the eradication and control of weeds.

CAKAUDROVE PROVINCE.

Four replies were received. Weeds found are Koster's Curse, Guava, Lantana, Blue Rat Tail, Thurston Grass. The principal industry is coconuts. Weeds not harmful to coconuts, but which interfere with efficient working of plantations are said to be Lantana, Blue Flower, Kaumoe and Sensitive Grass. One writer states that he successfully got rid of Guava on his property by removing all stock, cutting down the trees two feet from the ground and allowing Mile-a-minute to grow over the stumps. The result of this is that there is no Guava whatsoever on the area dealt with. The same writer states that Koster's Curse and Lantana can be dealt with in the same manner in that area. Lantana is said to grow rapidly and thickly on the flat where the soil is good but in other parts is not troublesome. Koster's Curse appears to be increasing. An attempt is being made to smother the Koster's Curse by planting Rice Bean. Lantana and Koster's Curse grow densely on native lands in the vicinity of European-owned estates and render it much more difficult to maintain effective control. Birds are regarded as the main factors which cause the spread of these two weeds. It is interesting to note that another plantation manager states that systematic weeding, grazing of cattle and periodic cutting of Koster's Curse and pulling out Lantana at a cost of 4s. 6d. per acre per annum is effective. Again birds are regarded as the worst offenders in assisting the spread of Koster's Curse and Lantana. Large areas of unoccupied land maintain a constant source of seeds for the reinfestation of clean areas. Still another planter removes harmful weeds by hand at a cost of 38.4d. per acre per annum.

KADAVU PROVINCE.

One reply was received indicating that the area in question is free from troublesome weeds.

LOMAIVITI PROVINCE.

Four replies were received, three from Ovalau and one from Gau. A reply from the Cawaci Mission states that crops grown are yams, taro, bananas, tapioca, sweet potatoes and European vegetables. Weeds appear not to be troublesome. Guava is kept down by regular weeding and Lantana, Mile-a-minute, Blue Rat Tail and a little Koster's Curse encountered are pulled up whenever found. A kind of Burr (unnamed) appears to give a little trouble. Paddocks are kept in order by regular weeding and burning, followed by planting of grass. The work is done by school boys. Apart from the Burr the weeds are not increasing. Cattle are said to contribute very much to the spread of Guava, which is kept under control by cutting down to ground level twice a year. The Burr appears to be a serious pest. It grows fast and the seeds stick to anything which touches them so that it is easily and rapidly spread. Blue Rat Rail is best dealt with by complete uprooting. Mere cutting simply acts as a form of pruning and the plant grows again with increased vigour.

A further reply from Cawatara, Ovalau, is in similar terms to the one dealing with Cawaci.

In cultivated land on the West Coast of Ovalau, Koster's Curse, and Solanum are regarded as serious pests but have been satisfactorily dealt with by chopping down to ground level and ploughing out the roots. The crops grown are maize, coconuts, pineapples, bananas and rice. Weeds are kept in check by periodic weeding and ploughing. The cost per acre of initial clearing is said to be £3.

Gau.—Referring to a coconut plantation the writer reports Guava and Koster's Curse to a small extent, with Blue Rat Tail. All are kept under control by clearing. Cattle are employed to keep the growth under nuts in check. The annual cost of weed control is said to be about 10s. per acre. Guava appears to be slowly increasing though Koster's Curse is kept in check but is likely to increase in the future owing to the heavy infestation of native areas. Kaumoce is said to be a nuisance.

LAUTOKA PROVINCE.

One reply was received, from the Manager of the Colonial Sugar Refining Company Limited, in the form of a general statement as below:—

The most prominent noxious weeds in the canefields and the degree of infestation are described in the following notes of our Mr. Greenwood.

These weeds are dealt with to some extent by the hoe, or in the case of Para Grass by a digging fork and to a greater extent by the use of weed destroying implements, either tractor or horse drawn. In the case of Para Grass on fallow lands, harrowing down and burning followed by one or more shallow ploughings has met with success frequently.

Their growth on fallow lands is checked by bare following with occasional stirring of the soil by implements and by the practice of planting a leguminous green manure crop.

Our unused areas being mostly barren hills do not generally afford a breeding ground for noxious weeds.

Guava has occasionally been troublesome and on land which it is intended to cultivate, cutting down, burning off and ploughing out the roots has been found the most useful way of dealing with it.

NOTES BY WILLIAM GREENWOOD, H.D.A., F.E.S., F.L.S.

Excluding the grasses, some of which are useful for fodder, and the legumes, most of which are beneficial to the soil, there are, in the Lautoka, Nadi and Sigatoka cane areas, about 60 weeds. The majority of these are of no great importance at present and do not occur in large numbers but the cane fields would be better without them. A list of the more important of these weeds with short notes is given below:—

Panicum maximum, Jacq. (Guinea Grass).—This excellent fodder grass occurs in all the three districts under consideration and in the cane fields must be regarded as a weed.

Brachiaria mutica, Stapf. (Para Grass).—Another excellent fodder grass which is a great pest in most low lying cane fields. It is common in all three districts.

Sorghum halepense, Pers. (Johnson Grass).—A bad weed in cane land but only occasionally seen in the Lautoka, Nadi or Sigatoka Districts and at once dug out by the roots and burnt.

Mikania scandens, Willd. (Mile-a-minute).—This climber, although eaten by cattle and recommended as a cover crop to keep down weeds in other parts of the world, is a very bad weed pulling the cane down in our cane fields, more particularly in the Sigatoka District.

Lantana camara, L.—A small patch of this weed was found in cane fields at Lautoka a few years ago and was destroyed. A few scattered seedlings from this patch were found later and were also destroyed and during the last two years no more has been seen.

Triumfetta rhomboidea, Jacq. (Chinese Burr).—This hard woody plant is a common weed in all cane areas.

Psidium guajava, L. (Guava).—Although not a weed in the actual cane fields, this common shrub soon appears in fields which are out of cultivation for a couple of years and on account of having to be grubbed out, much increases the cost of bringing these fields under cultivation again.

Xanthium chinense, Mill. (Noogoora Burr).—This very bad Australian weed was found in the Lautoka District about ten years ago and was destroyed. Various plants were found in the following years over a small area and were dug up and burnt. It has not been noticed during the last two or three years.

Solanum torvum, Sw.—This plant, which was common in parts of Fiji in 1906, is a bad weed on most river bank lands in the Lautoka, Nadi, and Sigatoka Districts, but not in the cane areas.

Ipomoea coccinea, L., *I. quamoclit*, L., and *I. quinquefolia*, Griseb.—The first two of these creepers have red flowers and are common in the Lautoka and Nadi Districts. They seed profusely and smother the young cane after the manner of Mile-a-minute. The third species *I. quinquefolia* Griseb, has not been noticed at Nadi or Sigatoka yet. Its effect on cane is just as bad as that of the others.

Cyperus rotundus, L. (Nut Grass).—This weed is common right through the three Districts and like most *Cyperaceae*, is worst in wet soils. In Hawaii an attempt is being made to reduce it by means of insects and the experiment is being watched with interest.

No mention has been made of the various legumes found in cane fields such as Sensitive Plant, *Phaseolus*, *Crotalaria*, &c., as these plants enrich the soil in which they grow and are often sown as cover crops in other tropical countries.

LAU PROVINCE.

One reply in respect of coconut plantations on Kanacea Island was received. Weeds reported are Guava and Seed Grass. The clearing of dense Guava is effected by cutting and stacking for burning at a cost of 9s. to 12s. 6d. per acre. New growth is controlled by slashing and by allowing Kaumoce to form a heavy cover crop. The annual cost of controlling Guava is said to be 2s. to 2s. 6d. per acre. As the island is isolated and privately owned it is not troubled by the appearance of various noxious weeds met with in other parts of the Colony and those weeds that are present are decreasing. Experience has shown that care must be exercised in dealing with Guava. Initial clearing should be done from November to January thus giving the cover crop a full season's growth. It has been found that the growth of an annual cover crop such as Mile-a-minute, Sensitive Grass, or Kaumoce is more rapid than that of Guava. The cover crop is usually left until the following April and appears to stifle successfully the growth of the Guava. The average rainfall on the island is 58 inches per annum.

MACUATA PROVINCE.

One reply was received from Dreketi. The weeds reported are known in coconut plantations and on areas where no cultivation is practised. Guava is regarded as the most serious. The idle lands act as the centres for reinfestation of districts where weeds are kept under reasonably good control.

The informant deals also with the question of uncontrolled animals such as wild pigs and cattle.

Other weeds which cause trouble are Kaumoce, and Blue Rat Tail. Mile-a-minute is found to check the growth of cut Guava but in young coconuts it is itself a source of trouble. Kaumoce and Sensitive Grass are not troublesome weeds in mature coconuts, but need attention on cultivated land. Kaumoce is regarded as a valuable green manure.

NAITASIRI PROVINCE.

Three replies were received. The province is subject to heavy rainfall. Sugar cane is the principal crop, but general cultivation and dairy farming are carried on. Cultivation on arable land reduces considerably the trouble experienced with noxious weeds. In the cane lands, Para Grass, Sensitive Grass, Mile-a-minute and Solanum obtain a hold when land is left fallow, but all are very easily controlled by cultivation. The greater portion of the hill land is not under cultivation and is infested with Koster's Curse, Guava, Mile-a-minute, Solanum and other vigorous weeds which have ousted Para and other grasses of value to dairymen. The hill soils vary considerably, but poor light clay is predominant. Methods of control on areas under cultivation for cane are ploughing and harrowing, but occasional patches of Solanum and Johnson Grass are dug out by hand.

The Colonial Sugar Refining Company Limited, has found that Koster's Curse can be controlled by ploughing and vigorous harrowing, as also can Para Grass. Lantana and Solanum may be partially controlled by cutting back and digging out. Sensitive Grass and Mile-a-minute can only be checked by hand weeding, but even then Mile-a-minute often gives considerable trouble in the cane crop, causing fallen stools and low quality cane.

The Methodist Mission at Davuilevu states that on their cultivated land the infestation of weeds is slight. There is heavy growth on uncultivated hills where Koster's Curse, Lantana, Solanum and Guava are met with. Para Grass has been found to check the growth of some weeds but as already observed this plant is itself regarded as a nuisance in certain areas. Stock are run in the Para Grass. Weeds are kept in check on closely cultivated land and in pasture by not permitting stock to eat down Para Grass to such an extent as to encourage the growth of weeds. Noxious weeds are said to be decreasing. Elephant Grass has been found to be keeping out weeds from hill areas. It is said to be easily controlled and is readily eaten by cattle and pigs. If cut down frequently the fresh shoots make excellent green food for poultry. The writer recommends that Elephant Grass should be planted on the hills for keeping down noxious weeds and thus extend the area available for cattle grazing. Solanum is kept in check by school children who are sent out on certain afternoons when the plant is flowering with instructions to slash. It is suggested that school children could with advantage be used more generally for this purpose during certain periods of the year.

In another area where grazing and crop raising are carried on Koster's Curse is the principal weed. Solanum and an unnamed burr occur to a small extent. Sensitive Grass is also met with. For periodical cropping the land is cleared by mowing and ploughing and for the establishment of pastures these operations are followed by the chopping of Para Grass which is disced in during wet weather. Ten acres badly affected with Koster's Curse and Sensitive Grass were cleaned by mowing and ploughing at a cost of £2 5s. per acre. Cutting and grubbing is said to cost more than three times as much. Little trouble is experienced in controlling weeds in arable lands, but to keep them down in pasture lands costs about 10s. per acre per annum. Weeds are said to be spreading in the district. A small root worm has been observed which appears to destroy a good deal of Koster's Curse on hill lands. Weeds are spread by cattle and birds. The methods practised for the control of Koster's Curse are mowing and burning followed by double ploughing and later by systematic grubbing. Solanum is kept in check by grubbing twice annually, Burr by grubbing in the autumn and Sensitive Grass by an annual mowing.

NADROGA PROVINCE.

Two replies were received. Weeds reported are Guava, Solanum, Nut Grass, and Koster's Curse, which are said to be increasing in the district on pasture lands, but diminishing on cultivated lands. Native land is the main breeding land for noxious weeds and general control is impossible on vacant lands even if supervised by a staff of inspectors backed up by the law. It is considered that no other practical methods of control except closer settlement and increased cultivation and greater care of pasture lands will be successful. The overwhelming argument against various methods of control is that there are not sufficient people in Fiji at present to cultivate all the land.

In cultivated land Guava is dug out with Demarara spades and mattocks by contract. Initial clearing costs £3 per acre. Weeds are kept in check on arable land by cultivation and in some pasture land by burning off in dry weather and digging out. Birds, such as Mynahs and Bulbuls spread Guava and Solanum, and cattle eat the Guava fruit and spread the seeds. Flood waters carry the weeds of Solanum and Koster's Curse. The only effective method for controlling Guava is burning-off and digging out stumps. This would appear also to apply to Solanum and Koster's Curse. In the case of Nut Grass a parasite found effective in Queensland has been mentioned but it is doubtful whether it would prove useful as land must be allowed to lie idle for a number of years, although it would be worth while to institute inquiries.

NADI PROVINCE.

One reply received. Sensitive Grass has been found troublesome in pineapple land. Disc ploughing is utilised for initial clearing and the land is kept free from weeds by intense cultivation. Experience in cane growing in Queensland is said to have shown that the best method of controlling Sensitive Grass is by cultivation and spraying with a solution of arsenite of soda. The uncontrolled grazing of stock appears to be the principal means of spreading weeds and it is recommended that graziers should be compelled to keep their lands free from noxious weeds. Vacant lands owned by absentees form breeding grounds for weeds which spread rapidly and control by resident cultivators is rendered considerably more difficult.

SERUA PROVINCE.

One reply received. Large areas of unoccupied European land are covered by a dense growth of Koster's Curse and some land which is nominally occupied is infested with noxious weeds, particularly Koster's Curse, the seeds of which are spread by the mongoose and birds. The cost of clearing noxious weeds is much heavier near the boundaries of areas used for pasture purposes than on those paddocks which are more distant from the centres of infestation. Koster's Curse appears to be the most serious weed encountered and so long as large areas remain without any attempt to control the weeds, the task of those who are endeavouring to keep their land clear will be rendered difficult and expensive.

REWA PROVINCE.

One reply received. Weeds encountered on pasture land are Koster's Curse, Solanum and Lantana, which are sparse on account of the control exercised. Principal crops grown are sugar and rice and a little maize. The weeds are kept down by constant cultivation. Initial clearing of noxious weeds varies from 30s. to 53s. per acre according to the density of the growth. In arable lands weeds are kept under control by cultivation and in pasture land by constant cutting and rooting out. Unused areas are left until required as the cost of control of weeds is too excessive to do otherwise.

Control of weeds in pasture lands costs £1 per acre per annum. Solanum is said to be increasing rapidly. Koster's Curse and Lantana apparently are stationary. Heavy growth of Mile-a-minute has been observed to check the spread of Koster's Curse, but appears to have no effect on Solanum or Lantana. Birds cause re-infestation of cleared lands rapidly. Pasture land once thoroughly cleared of weeds can be kept practically clear from them by one man to every 50 acres.

RA PROVINCE.

The following extract is taken from the one reply received from the Manager of the Colonial Sugar Refining Company Limited, Penang:—

The area held by us here is about 18,000 acres of which about 4,500 acres are, or will be cultivated for cane, and the balance is hill land of which perhaps half could be used for grazing. The main crop is cane, though small areas are devoted to rice and maize.

The only noxious weeds of importance here are Ellington Curse and Guava and neither of these give any trouble on the cultivated areas. Koster's Curse and Solanum I have not seen in the district. A couple of years ago there was a small amount of Noogoora Burr, but this has been destroyed and is not now in evidence.

Ellington Curse is fairly dense on some of the steeper and stonier hills at Ellington but outside that area it is sparse to negligible.

Ellington Curse seems to prefer good soil but grows equally well on stony hills and on the sandy soil of the sea shore just above tide reach.

Guava is dense on some of the hills nearer Penang. It prefers good soil and its growth is of small account on the distinctly poorer soils.

The only method which seems to avail against Ellington Curse or Guava is to grub it out, roots and all.

We have done no clearing of either growth ourselves and cannot compare the probable cost. Considerable areas have been cleared by our tenants, however, and they invariably cut down the bushes and grub out the roots with mattocks. There is no sign of either weed returning on the cultivated land.

In my opinion Guava is a much greater nuisance than Ellington Curse because birds and cattle carry the seed which is quickly re-sown on cleared land; but neither birds nor cattle appear to touch the seeds of Ellington Curse so that the growth can only spread slowly around the parent plant.

Ellington Curse, however, has large thorns which are to a certain extent poisonous and on this account it is a bad weed to have in cattle country.

COLO NORTH PROVINCE.

One reply received, in respect of grazing land. Guava is the principal serious weed met with. Effective clearing has been done by cutting above the ground when the sap is down and poisoning with a solution of arsenite of soda applied to the freshly cut stump with a paint brush. The cost of clearing and cultivating land heavily infested with Guava is £3 10s. per acre. Ellington Curse is also met with and is kept under control by constant grubbing. Guava is said to be increasing alarmingly throughout the whole district. The ripe fruit is eaten by horses, cattle, pigs and a number of birds, and the seeds are spread by the droppings. Young plants are observed coming up freely in the wet season and apparently have no natural enemies. The main solution in regard to Guava seems to be the prevention of fruiting. Ellington Curse is confined to the coastal areas and its spread is much more gradual. Solanum and Lantana are found in the mountain area and along the water ways. Seeds of Solanum are spread by birds. The spread of Guava on grazing land is regarded as a serious economic problem. It is suggested that Government should let grazing land on a longer lease and make the control of noxious weeds a condition of the lease. Short leases and high rentals are regarded as a contributing factor to the invasion of weeds. The writer states that in his view there are some one and a half million acres of grazing land within sixteen miles of the coast between Vitilevu Bay and Sigatoka and that of this one quarter is infested with Guava. The possibilities of biological control should be explored. Fijians should be debarred from giving yearly terms for the occupation of land to any person for the purpose of grazing, as in such cases occupants move at the end of two or three years and leave the land infested with weeds which gradually infest the surrounding areas.

TAILEVU PROVINCE.

Ten replies were received. The principal weeds are Guava, Koster's Curse, Solanum, Burr, Kaumoce and Blue Rat Tail. Koster's Curse has

obtained a firm hold in the district and may be observed growing luxuriantly on large areas. Hand clearing, followed by burning, ploughing and harrowing is used to clear land of noxious weeds, for the establishment of pastures. Direct ploughing by a tractor and disc plough has recently been practised, but it is early to state whether this is an effective method unless followed by further clearing of secondary growth. Noxious weeds in the pastures of the dairy farms are a constant source of trouble and expense to the dairymen. The annual cost of maintaining pastures reasonably free from weeds ranges from about 7s. 6d. to £1 per acre per annum. Initial clearing of noxious weeds costs from 30s. to £3 per acre, according to the degree of infestation and the nature of the weeds. Koster's Curse is kept under partial control in pasture by cutting out with knives, pulling out the roots or grubbing with a mattock. It is suggested that a grass of good quality that will cover the ground in a close mat will assist considerably in controlling weeds. Sensitive Plant it is said by some dairy farmers to check very considerably the growth of Koster's Curse. The application of manures to pastures at the proper time encourages the growth of grasses at a greater rate than that of weeds and helps to keep the latter under control. Birds and the mongoose are the principal agents that cause the spread of noxious weeds. One writer states that steps should be taken to exterminate wild pigeons and that in any case they should be no longer protected.

A letter dealing in general terms with this subject was received from one of the Firms who control large interests in the Colony, pointing out that the great danger from noxious weeds in the majority of cases lies in the unused or partly used native land. This increases the difficulty of the problem enormously because even if Government took steps by statute to enforce their labour the available Fijian population is not large enough to deal with periodical weeding of their land and moreover, the value of the great portion of that land is so low as to make it impossible to recoup the cost of controlling the weeds growing on it. The problem is, however, complicated by the continued fall in the market value of copra, which has rendered it necessary to reduce plantation costs to the lowest possible limit with the result that periodical weeding has been one of the first services to be sacrificed.

SUMMARY.

A survey of the question of noxious weeds in Fiji indicates that there are some five aspects of the problem. These are:—

Weeds in—

- (a) cultivated land;
- (b) grazing areas;
- (c) dairy farms;
- (d) coconut plantations;
- (e) unoccupied native and other land.

The control of noxious weeds in arable land is not a serious problem, although the annual cost is increased because of the large areas infested with weeds contiguous thereto. In grazing land where large areas are stocked with cattle at the rate of one beast to several acres, weeds are increasing and the available grass land is being reduced at a rapid rate by the spread of Guava and other objectionable plants. The control of weeds in such areas is undoubtedly a very difficult problem and the constant cutting and grubbing which can be practised in dairy farming areas where intensive grazing is carried on are impracticable in other grazing areas.

In the dairying areas it appears possible without great difficulty to keep pasture land reasonably free from weeds by constant attention, but the cost

of this work is a heavy charge on the dairy farmer and difficulties are again increased by adjacent heavily infested areas which re-infest the pasture lands rapidly.

In well-run coconut plantations periodical weeding is normally practised, but there can be no doubt that the fall in the value of copra will lead to a considerable curtailment of the expenditure for upkeep and maintenance of plantations, and weeds may rapidly obtain a firm hold in areas which have for many years been reasonably clear.

Vacant lands, many of which have at some time or other been under cultivation, are a constant menace to every phase of agriculture in the Colony. As has been seen the fruits of many of the weeds are eaten by birds, mongoose and other animals and spread by their excrements. Though there seems little hope of justifying the enormous cost of clearing these vacant lands of weeds or even of keeping the heavy growth under reasonable control, it would appear advisable to limit as far as possible the agencies which distribute the seeds.

From the information available it appears that Guava may be regarded as the most serious weed in Fiji. It is spread easily, grows rapidly and if unchecked develops into a sturdy tree which is costly to cut out, although the wood is a valuable fuel and makes excellent charcoal. Koster's Curse grows luxuriantly and spreads rapidly but appears not to deplete the soil of plant food to an undue extent. It can be dealt with without great difficulty on land which it is desired to bring under cultivation, but is a more difficult problem in dairy lands where it springs up rapidly if care is not constantly exercised.

Lantana in several districts is being kept under control biologically by the insects imported from Hawaii and the more general distribution of these insects as colonies become available will undoubtedly contribute to the destruction of this weed. Prickly Solanum appears to be increasing in many districts. It is of sturdy and luxuriant growth and fruits heavily. Although cattle occasionally eat it when more attractive fodder is not available they cannot be said to keep it under any degree of control. Blue Rat Tail is a nuisance wherever found and simple cutting is useless in endeavouring to control it. It must be uprooted completely if it is desired to eradicate it from any area.

It appears impossible to institute one method for the complete control of the more important noxious weeds of the Colony. Methods must be adapted to the principal needs of the various agricultural pursuits, and for this reason it is hardly necessary to consider the problem of arable lands where constant cultivation is necessarily practised in connection with the growing of crops. It will therefore be convenient to consider land which falls into the three categories—

- (a) dairy land;
- (b) land under permanent crops, *e.g.*, coconuts;
- (c) vacant land.

Apart from the methods already briefly discussed there appear to be three possibilities—

- (1) biological control;
- (2) destruction of plants by spraying;
- (3) the use of beneficial cover crops, or permanent crops which will repay the cost of their planting during the early stages of growth.

In connection with (3), the matter of afforestation arises.

(To be continued.)

COPRA DRIERS—REPORT OF VISIT TO WESTERN SAMOA.

By A. C. BARNES, F.I.C., B.Sc., A.M.I.Ch.E.

INTRODUCTION.

THE primary object of my visit to Western Samoa was to examine the types of copra drier in use on the New Zealand Reparation Estates. The opportunity was taken of visiting other plantations where artificial driers were in use, and of investigating to some extent the manner in which the copra industry was conducted on the Estates. In addition, inquiries were made into the present position and prospects of the banana industry, a subject which has been reported upon separately.

2. I received every possible assistance from Officers of the Government of Western Samoa, and of the Reparation Estates, and was afforded opportunities for making as complete an investigation as was permitted by the limited time available. The Manager of the Estates accompanied me on visits to the plantations under his charge on four days, and supplemented the observations I was thus able to make by supplying detailed information and plans from his records.

PLANTATIONS VISITED.

3. The Reparation Estates consist of a number of plantations, of which I visited three, Vaitele, Vailele, and Mulifanua. A drier belonging to Mr. Mauritz, and a small village drier erected by the Government for native use were also inspected. Visits were made to the estates of Mr. Brighthouse and Mr. Cobcroft, on both of which driers were in operation.

THE COPRA INDUSTRY ON THE REPARATION ESTATES.

4. Before proceeding to describe in detail the various types of copra driers examined, it may be well to deal briefly with the general manner in which the production of copra is carried out on the Estates.

5. The coconut plantations are well laid out and the trees have been regularly planted, 30 ft. by 30 ft. square. The soil is volcanic and rocky, volcanic stones being in evidence on most of the areas, so that mechanical cultivation is impossible and hand weeding difficult. Ground cover consists mainly of sensitive plant (*Mimosa pudica*) and cattle are run on all plantations. They successfully keep down the growth and form a valuable source of revenue. The plantations carry about one animal per acre.

6. A recent muster gave returns as follows:—

<i>Plantation.</i>	<i>Area.</i>	<i>Stock.</i>
Vaitele	1,473 acres	1,660 cattle. 40 working bullocks. 45 donkeys.
Mulifanua	4,200 acres	4,277 cattle.

7. The plantations are well fenced and subdivisions are further divided into grazing areas of convenient size. Iron spiral fencing posts are being used to an increasing extent. They are cheap, of light weight and strong. The cost *ex* New Zealand landed in Samoa is 1s. 6½d. per post, but I am informed that they can be imported direct from England to Fiji at a landed cost of 1s. 2½d.

8. Good roads exist on all the plantations and greatly facilitate the work of nut collection, general transport and communication. Though

bullock carts are largely used at present, some motor trucks are employed, and it is understood that motor vehicles will be used to an increasing extent in the future.

9. The Estates are divided into units of convenient size for ease of working, and an artificial drier is located in each subdivision. The collection of nuts is carried on by groups of coolies who work systematically through the area in such a manner that a complete cycle occupies about six weeks. Donkeys with pannier baskets are used to carry the nuts to the roads, where they are dumped, loaded into bullock waggons and thus carried to the cutting station situated near the drier. Here the nuts are placed under shelter in readiness for the cutters, who are divided into two groups, one of which splits the nuts while the other cuts out the copra and places it into boxes for transference to the drier. The floor of the portion in which the nuts are split open is covered with sections of coconut tree trunks lying transversely and in this manner the nuts are conveniently chopped open by an axe while the "milk" runs down between the logs into a drain.

10. The daily tasks for these operations are as follow:—

					<i>Nuts per man per day.</i>
Collecting	..	..	..	..	1,200
Chopping	..	..	..	..	4,000/4,300
Cutting out copra	..	..	..	..	600 lb (net)

11. The green copra is transferred to the drier with a minimum of delay and there can be no doubt that this contributes largely to the high standard of quality of the product.

TYPES OF COPRA DRIERS.

12. On the Reparation Estates two main types of driers are in operation and may be referred to respectively as the German Drier and the Chula. Different examples of each of these types are in use and will be described separately.

13. The German driers are essentially of the hot air type with natural draught. They consist of a masonry chamber over which is constructed the drier proper which includes a drying chamber and a loading and discharging platform. The driers vary in size and capacity and although there are several of them no two are alike. It is evident that when they were constructed certain variations were resorted to, possibly with the object of determining the best design for final adoption.

14. At one end of the masonry chamber below ground level, is a fire-box with an extended combustion section, from which a rising pipe leads to the air heating pipes and thence to the chimney, which is erected outside the building. The air heating pipes are arranged at different levels, and are so constructed that their ends are set in the walls of the chamber and can be opened for cleaning. Connection between successive pipes (or flues) is made by short transverse sections of the same diameter of pipe.

15. At ground level, the chamber is pierced by a number of apertures which are capable of being opened and closed at will, thus allowing ingress of cold air which is subsequently heated by the pipes and rises into the drying chamber, finally passing out through a ventilator or ventilators in the roof.

16. Firing is affected by coconut husks with attached shells. Practice has shown that the fuel from a given quantity of nuts is more than sufficient to dry the copra from these nuts. The design is shown in the diagram.

Detailed plans were furnished by the Manager of the Reparation Estates, and may be consulted at the offices of the Agricultural Department. It will be convenient for this purpose of the report to describe a two-compartment drier.

17. The fire-well is 6 ft. deep and furnace 4 ft. 6 in. long to the face of the sloping fire brick end, with an ash-pit 18 in. deep below the fire bars. A 12 in. aperture above the fire brick face leads into an extended combustion chamber, which has a cleaning well at the far end. From this a rising pipe about 18 in. in diameter leads to a level heating pipe within the masonry chamber and to a further inclined pipe passing in the opposite direction which joins the chimney.

18. Usually the air heating pipes are fixed longitudinally under the drying compartments, one pipe running underneath each compartment. In one instance, however, these pipes are set transversely, and it is stated that this particular drier gives better results than the others.

19. The masonry chamber is 7 ft. 6 in. high, 7 ft. 6 in. wide and 15 ft. 9 in. long. The centre line of the inclined heating pipe is 3 ft. 9 in. above ground level at one end, and 4 ft. 3 in. at the other. The bottom of the drying chamber is open. The necessary structural rigidity is secured by a heavy rail, laid longitudinally, carrying the centre wall of the two compartments.

20. Each compartment measures 3 ft. 1 in. from wall to wall and is 9 ft. 6 in. high and 16 ft. 3 in. long. Hardwood runners for 18 tiers of trays in each compartment are fitted to the wooden walls which are hollow and filled with sand to secure heat insulation. The trays themselves are 3 ft. by 2 ft. with wooden frames covered with half-inch square mesh wire. On the bottom, hardwood strips are nailed over the wire mesh to facilitate the movement of the trays within the drier. The substitution of hardwood runners on the walls of the drying chamber with angle iron has been found effective in facilitating working and reducing wear.

21. It will thus be seen that each compartment is capable of carrying 144 trays if completely filled, but in practice the lowest trays are covered with fine mesh netting in order to catch small particles of copra and dust which might otherwise fall on the heated pipes and add to the risk of fire. The first two or three runners are generally left devoid of trays. During the course of the drying the position of the trays is changed from time to time. A long pole with a hook on the end is used to pull the trays from the far end of the drying chamber.

23. The chambers are closed completely at one end, doors being placed at the other, where the handling, changing and discharging takes place entirely. The design would be improved by fitting doors at both ends, but in this case the building in which the drier is housed would need to be extended. In the middle of the roof of the drying chamber is situated a transverse ventilator 6 ft. 8 in. long by 2 ft. wide and 7 ft. high.

24. The drying chamber is housed inside the building which is floored at both sides and one end. The floor of this is 7 ft. 6 in. above ground level and access to it is afforded by steps. It will thus be seen that the disadvantage of the drier is that the floor of the loading platform is considerably above ground level and the green copra and the dried copra have to be carried up and down respectively. To construct this type of drier in such a manner that the loading platform is at ground level would involve costly excavation.

25. The space on each side of the drying chamber is utilised for bagging the discharged dry copra without interfering with the normal working of the drier. The capacities of driers of this type are as follows:—

Two-compartment	..	2,500/3,000 lb green copra.
Three-compartment	..	4,000/4,500 "
Four-compartment	..	5,000/6,000 "

26. The time required for drying is 30–36 hours. The product is clean, white and apparently of excellent quality. The results of analyses of samples taken from these driers are given in the Appendix.

27. The estimated cost of erection of a three-compartment drier is £550, and the cost of drying, including all charges is £1 0s. 5d. per ton. This is worked out as follows:—

Depreciation buildings, 5 per cent...	..	..	£27	10	0
Repairs, &c. (estimated)	..	..	..	20	0 0
Flue pipes, furnace, smoke-stack and renewals	..	..	..	20	0 0
(Total £60 cost for 3 years)					
Labour—1 night and 1 day boy	..	..	..	94	0 0
Repat. and Rec. charges	..	..	..	15	0 0
Renewal trays and runners	..	..	..	10	0 0
Interest—6 per cent. on capital	..	..	..	33	0 0
Overhead plantation based on $\frac{1}{3}$ labour cost	..	..	..	31	0 0

					250 10 0
Kerosene (lights)	..	..	..	..	5 0 0

Annual cost £255 10 0

Four dryings a week—270 tons p.a.; allow 1 month p.a. for repairs—250 tons=£1 0s. 5d. per ton for maximum drying.

NEW TYPE OF HOT AIR DRIER.

28. An interesting drier of somewhat unusual construction has been erected by Mr. Mauritz for drying green copra purchased from natives. This again is a hot air drier, the heating being effected by a furnace with flue or flues passing through a longitudinal air mixing chamber. Above this chamber on one side, the drying chamber is constructed consisting of a large sloping wooden box, divided into compartments. Hot air from the air mixing chamber is admitted through a vent at the lower end of each compartment and rising through the compartment emerges through a ventilator door which can be adjusted to control the rate of passage of air as well as the rate of drying. The drier that I examined had eight compartments each of which was 3 ft. wide, 8 ft. long and about 3 ft. in height. Five angle iron runners were fitted on each side of the compartment and small trays about 3 ft. by 2 ft. covered with wire mesh were used to hold the copra. The drying chamber is set at a slope of $12\frac{1}{2}$ deg. and charging and discharging is effected at the upper end, the more distant trays being moved by means of a pole with a hook at the end as already described. The capacity of the drier is 2,500 lb of green copra, equivalent approximately to 1,500 lb of dry. The period required to dry is about 24 hours. I was very much struck with this drier, which is of very simple construction and can be so built that charging and discharging takes place at a convenient height above ground level. The supply of hot air to each compartment can be regulated both by the door at the upper end as well as by slides over the hot air ducts at the lower end. Deflecting plates are fitted at the lower

end in order to ensure an adequate supply of hot air to the lower trays. It would be possible to construct such a drier with two wings set over the same mixing chamber with adequate heating by one furnace. I was unable to ascertain the cost of construction, but consider that it would not be more than two-thirds of that required for a three-compartment German type of drier having a similar capacity. The drying chamber is lined in each compartment with compressed megasse, a material which possesses heat insulation properties, and which is cheap and convenient to use for such a purpose. Hot air circulation is secured by natural draught only and no mechanical appliance of any kind is necessary for the operation of the drier. The slope of the drying compartments adds somewhat to the labour of discharging the dried copra, but as the trays are light and carry only a few pounds of copra each, this is not a serious disadvantage. (see diagram).

HOT WATER DRIERS.

29. Several hot water driers were installed by the Germans on various plantations in Samoa. The essential difference between them and the hot air drier described in the first instance is that the heating of the air for drying is effected by a system of hot water pipes placed underneath the drying compartments and connected to a water heater at the side. In practice it has been found that these give very satisfactory service. The cost of upkeep is low and temperature control is more readily effected than with the ordinary hot air type. I was unable to ascertain the cost of erection of a drier of given size operated by hot water. Particulars of a small one installed by the Samoan Government for village use are given in the Appendix.

TUNNEL DRIER.

30. Mr. Mauritz also has a tunnel drier with hot air circulation effected by a power driven fan. So far as I could gather this drier gives excellent service, but it appears to me to be unsuitable for general adoption in view of the cost of construction and the fact that it requires power and therefore some skilled mechanical attention to operate it.

31. It was interesting to observe that Mr. Mauritz had installed the new sloping drier over the same air heating and mixing chamber as is used for the tunnel drier, and that he used the new drier in preference to the old one,

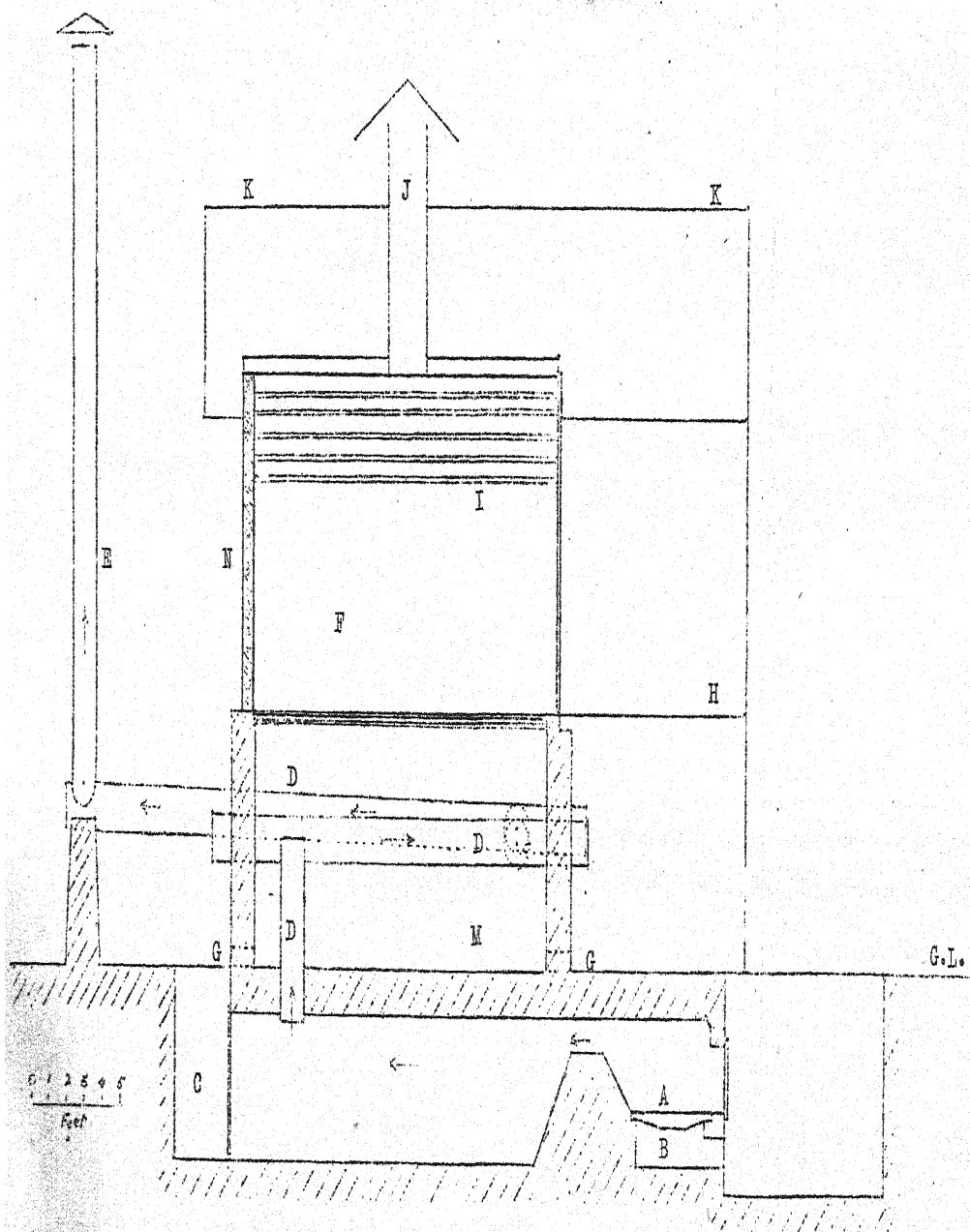
GORDON DRIER.

32. I had the opportunity of inspecting a Gordon Drier used in cocoa drying on the Estate of Mr. Cobcroft. As, however, this machine was not of particular interest from the point of view of copra drying, it is not necessary to describe it.

CHULA DRIERS.

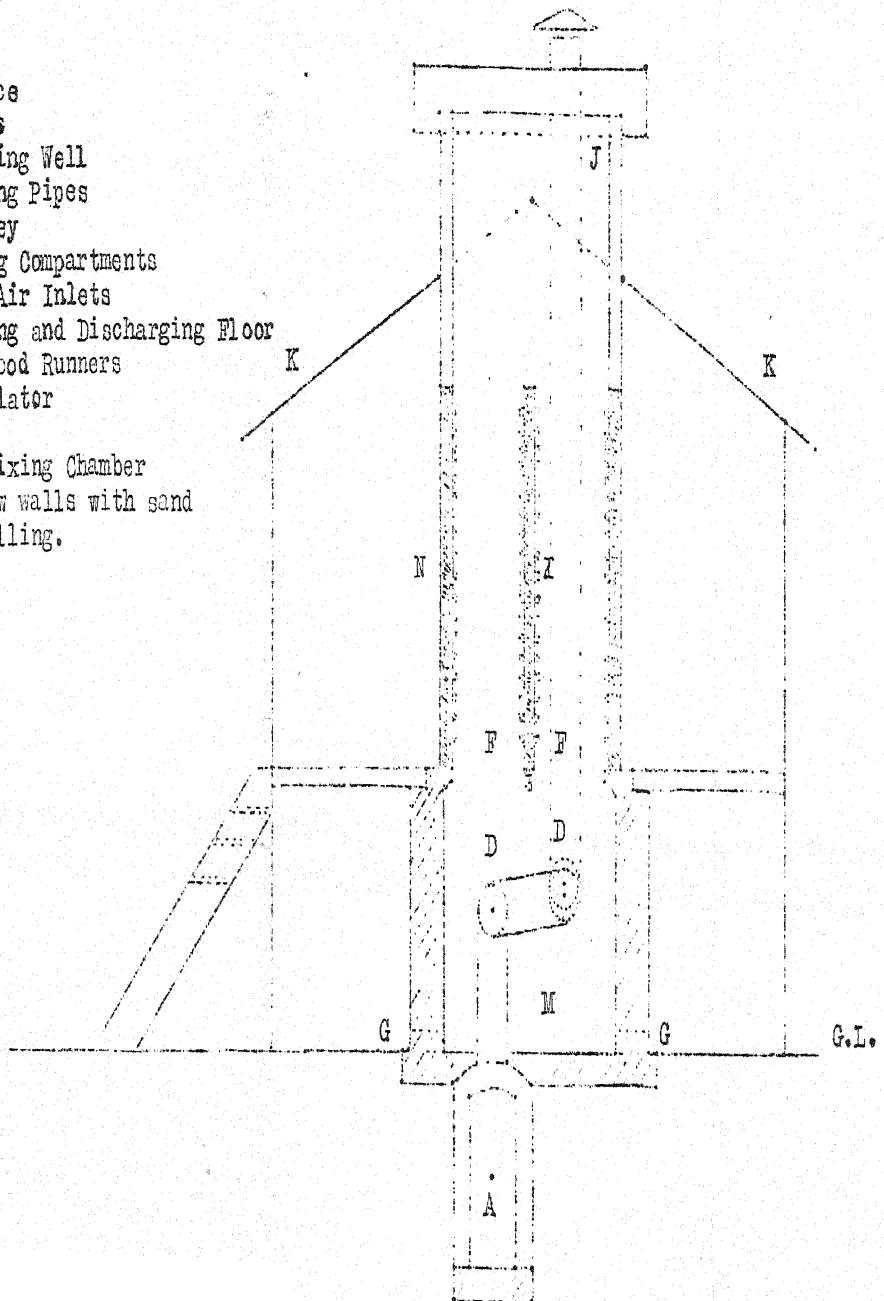
33. Two different types are in use on the Reparation Estates. A mechanically operated air circulation fan is common to both, except that the power used is different in each case. The Chula drier at Vailele is a so-called one-way drier; that is, the hot air circulates only in one direction and no means of reversing the air current are available. The copra is dried in bulk, and in practice it has been found that the material with which the hot air first comes in contact is dried comparatively rapidly, while that through which the air finally passes still has too high a content of moisture when the other is dry.

34. To overcome this difficulty a longitudinal partition has been put in the drying chamber so as to divide it into two equal parts. The system of working is such that the dried copra from the lower compartment is



TWO COMPARTMENT HOT AIR COPRA DRIER
 SIDE VIEW
 (Constructional details not shown).

- A. Furnace
- B. Ashpit
- C. Cleaning Well
- D. Heating Pipes
- E. Chimney
- F. Drying Compartments
- G. Cold Air Inlets
- H. Loading and Discharging Floor
- I. Hardwood Runners
- J. Ventilator
- K. Roof
- M. Air Mixing Chamber
- N. Hollow walls with sand filling.

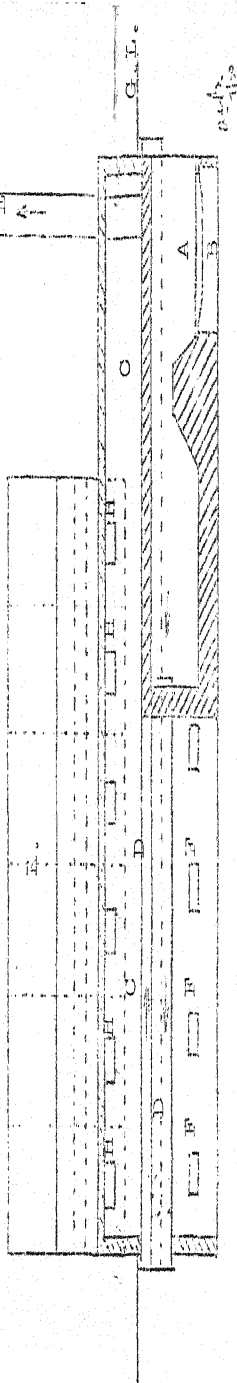


TWO COMPARTMENT HOT AIR COPRA DRIER
 END VIEW
 Part Section

- A.
B.
C.
D.
E.
F.
G.
H.
J.
K.
L.
M.

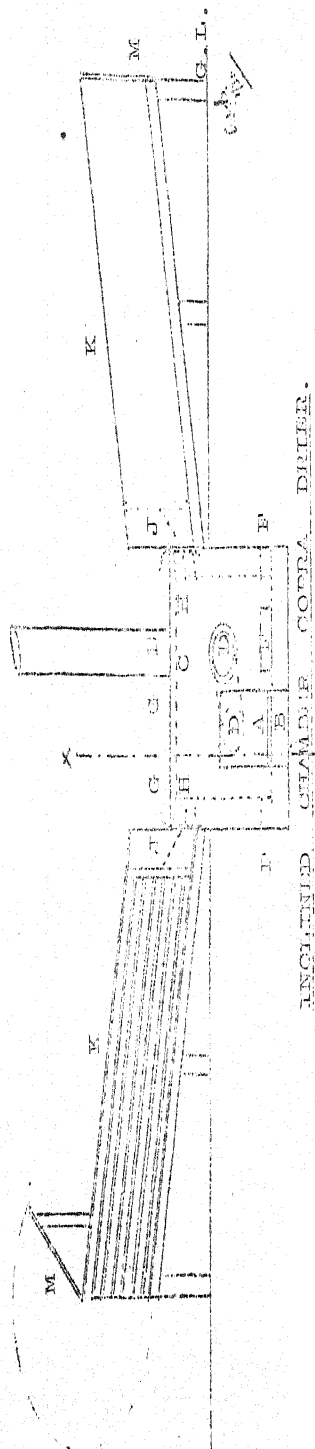
Burners.
Aspirator.
Mixing Chamber.
Flues.
Chimney.
Cold Air Vents.
Control Slides.
Hot Air Ducts.
Deflected Plates.
Inclined Drying Chambers.
Runners for Trays.
Doors.

0' 1" 2" 3" 4" 5" / feet



INCLINED CHAMBER COBRA DRIER.

Section through X.Y.



INCLINED CHAMBER COBRA DRIER.

End View.

discharged when ready and that from the upper is allowed to pass into the lower one, the upper one being again charged with green copra. In comparison with the other types of driers in use on the plantations, the Chula is very uneconomical. Drying costs are considerably increased by the necessity for skilled attention to the engine which drives the fan, and it is found that the rate of depreciation is high and repairs cost an excessive amount. The furnace, which is an essential part of the drier, appears to burn out fairly rapidly and to reduce costs of repairs and renewals a separate furnace has, in one case, been built.

35. At Mulifanua, there is a two-way Chula drier in which a more even drying of the copra is effected by reversing the hot air current by means of a slide operated above the drier. In this case a steam engine is used to drive the fan, whereas at Vailele an internal combustion engine is employed.

36. The capacity of the one-way drier is 2,500/3,000 lb of green copra and of the two-way drier 5,000/6,000 lb. Both machines take from 36/40 hours to dry one charge. Roughly, the cost of erection of a two-layer one-way drier of the stated capacity, with engine, is £800. The estimated cost of the necessary building in which to house it is £100. Details of the cost of drying are set out in the Appendix.

GENERAL REVIEW OF METHODS OF DRYING IN SAMOA.

37. Summarising the results of my observations which are supported by some knowledge of types of driers in use in other places, I put the driers described in the following relative order of preference, taking into account efficiency, ease of working, initial cost of erection, upkeep, depreciation and repairs and suitability for conditions in Fiji:—

- (1) The inclined chamber drier.
- (2) German type direct air heated drier.
- (3) German type hot water air heated drier.
- (4) Chula two-way drier.
- (5) Chula one-way drier.

38. In my view the inclined chamber drier represents a very considerable advance on anything I have yet seen of its capacity, though I am of opinion that a number of improvements could, with advantage, be effected.

GENERAL ECONOMICS OF THE PRODUCTION OF COPRA ON THE REPARATION ESTATES, WESTERN SAMOA.

39. *Yield per acre.*—As elsewhere, there is a considerable variation in the yield per acre per annum of copra on the Estates in Samoa. Records kept over the past six or seven years show that the yield ranges from 537 lb to 1,056 lb. The table below gives the highest and lowest figures recorded during that period on three of the Estates:—

		Highest.	Lowest.
Mulifanua	..	1,857 lb per acre	1,686 lb per acre.
Vaitele	..	1,056 "	626 "
Vailele	..	793 "	537 "

40. *Costs of production.*—The average number of units of labour required to produce one ton of dry copra was 40 in 1929. This includes labour for the cattle, which are run as an integral part of the plantation working.

41. The cost of copra at Apia is given as £9 9s. 4d. per ton f.o.b.—according to the detailed statement in the Appendix. Transport to Apia, insurance and the cost of bags and twine have been included. It should be

observed that the figures given include charges in respect of the stock industry and that the profits on sales of cattle have been deducted from the total cost thus arrived at.

41. *Marketing*.—Copra produced on the Reparation Estates is marketed in London, Hull and Hamburg. Freight costs £3 7s. 6d. per ton weight. Recent market quotations are:—

<i>Date.</i>	<i>Plantation.</i>	<i>Crown Estates.</i>
23/11/29	£21 10 0	£22 10 0
4/1/30	21 12 6	22 10 0
1/2/30	21 12 6	22 15 0
5/4/30	20 15 0	21 5 0
5/5/30	21 0 0	21 12 6
14/6/30	18 5 0	19 0 0

APPENDIX.

RESULTS OF ANALYSES OF SAMOAN COPRA.

<i>Sample</i>	<i>Moisture in vacuum oven at 100°C.</i>	<i>Oil on moisture free copra.</i>	<i>Oil on original copra.</i>	<i>Free fatty acid (Lauric).</i>
1. Vaitele, Mauga Station ..	7.76	67.53	62.29	0.30
2. Vaitele, Vaitele Station, drying completed 15/5/30, sampled 26/5/30	6.07	67.68	63.57	0.39
3. Mr. Mauritz	6.73	65.45	61.05	0.64
4. Vaitele, Suga Station, Chula, 26/5/30	7.54	69.50	64.26	0.27

The samples were in splendid condition and showed little sign of mould action. Samples Nos. 1 and 2, plantation copra, dried in German hot air driers. Sample No. 3, native copra, dried in inclined chamber drier. Sample No. 4, plantation copra, dried in one-way Chula drier. It should be observed that the moisture content has been determined in a vacuum oven which gives more accurate results than are obtained by the usual stem oven method when vegetable oil bearing materials are being examined. The figures may appear to be higher than normal in consequence. The analyses were performed by Mr. W. J. Blackie, M.Sc., Government Chemist.

PARTICULARS OF HOT WATER DRIER ERECTED AT VAISU VILLAGE.

Drying Chambers (3) ..	2 ft. 6 in. (approx.) by 5 ft. by 6 ft. high.
Runners	5 in. centres (approx.). (14 sets to each compartment).
Trays	28 per compartment.
Ventilator	5 ft. by 2 ft. (with control).
Heating pipes	128 feet of 2½ in. bore pipes with radiating fins, in two banks.

CHULA ONE-WAY.

Capital cost erected £800 with engine, building necessary estimated at £100.

ANNUAL CHARGES.

Depreciation, Chula 10 per cent., engine 10 per cent. ..	£80 0 0
Building, 5 per cent.	5 0 0
Pipes, furnace, smoke stack renewals	15 0 0
Engine boy, day and night, at £8 per month each ..	200 0 0
One boy for filling, &c. (Samoan)	180 0 0
Fuel, oil and repairs to engine	54 0 0
Interest on capital, 6 per cent.	31 0 0
Overhead at same basis as German	5 0 0
Kerosene	5 0 0
	£570 0 0

Capacity, 2,500 lb wet; annual output, 125 tons; cost per ton, £4 11s. 2d.

CHULA TWO-WAY.

Cost Chula, £971 4s. 10d.; boiler, £348; total, £1,300.

ANNUAL CHARGES.					
Depreciation buildings, 5 per cent.	..	..	..	..	£5 0 0
Chula and engine, 10 per cent.	..	..	..	..	130 0 0
Pipes, furnace, smoke stack renewals	..	..	..	..	25 0 0
Labour as one-way	..	..	..	..	200 0 0
Repairs engine, pulleys, shafting, belting, &c.	..	..	..	..	30 0 0
Lubricating oil	..	..	..	..	20 0 0
Interest on capital	..	..	..	..	78 0 0
Overhead on same basis	..	..	..	..	31 0 0
Kerosene..	..	..	..	..	5 0 0

£524 0 0

Capacity, 5,000 lb wet; time of drying, 36 to 40 hours; Annual output, 250 tons; cost per ton, £2 1s. 11d.

COST TON COPRA LANDED IN APIA YARD.

Vaitele; 476 tons; April 1st to March 31st, 1929-30.

<i>Labour direct.</i>	<i>Cost.</i>
Beetle searching	0 8 4
Weeding	1 3 4
Donkey boys	0 18 5
Transport—Bullock waggons, &c.	0 11 4
Choppers—One boy to six choppers	0 4 10
Cutters (average, 518 lb	1 6 0
Drier boys	0 13 1
Bagging and loading	0 1 9
Cattle, mustering, branding, killing, &c.; water-supply, fencing, roading, horses, breaking donkeys and bullocks, messengers, motor lorry drivers, paddocks, servants ..	1 15 1
	£7 2 2
Stores, being supplies of tools, fencing material, timber, petrol, and all necessary materials for use on plantations ..	0 13 5
Apia charges, rates, taxes, telephones, drier repairs, repairs to motor lorries and other direct charges from Head Office ..	0 19 9
Management—Salaries of Manager and assistants ..	2 4 0
Depreciation—Overhead, &c., building, plant and machinery, vehicle, harness and saddlery, motor lorries, furniture and fittings, &c., head office overhead charges, stationery, &c., &c.	1 7 0
	Total 12 6 4
Less profit on cattle	2 17 0
	£9 9 4

RHINOCEROS BEETLE—POSSIBILITY OF ACCIDENTAL IMPORTATION FROM SAMOA.

By T. H. C. TAYLOR, B.Sc.

THE Rhinoceros Beetle (*Oryctes rhinoceros*, Linn) is widely distributed in the Tropics. It is a well known pest of coconuts in India, Ceylon, Malaya, the East Indies and the Philippines and many other countries.

2. The beetle appears to have been imported into Samoa in or about 1910 from Ceylon in boxes containing rubber stumps packed in soil and vegetable refuse. It soon became a pest of major importance in Samoa and has done much more damage there than in the Far East, where it is indigenous, presumably owing to the absence in Samoa of its natural enemies.

3. On account of the close proximity of Fiji and Samoa and of the direct shipping communication between them, there is a risk of the beetle being introduced into Fiji. This risk was first appreciated in 1912, when

F. P. Jepson, Government Entomologist in Fiji, visited Samoa to investigate the matter and published a report thereon (Department of Agriculture, Fiji, *Bulletin* No. 3). This report, together with others which have since been published elsewhere (notably in the Philippines) constituted a fairly complete account of the various stages and habits of the pest, a thorough knowledge of which is essential if the insect is to be kept out of Fiji.

4. Twenty years have elapsed since the Beetle first reached Samoa and it has not yet become established in Fiji, so the risk cannot be very great. Nevertheless, the risk is always present and it is doubtful whether the Regulations concerning ships arriving at Suva from Samoa have been sufficiently strict in the past to eliminate it completely. The absence of the beetle in Fiji is probably due more to good luck than good management.

5. The work of Jepson in Samoa and of Mackie in the Philippines shows that the beetles lay their eggs in rotting vegetable matter, chiefly in dead coconut trunks and stumps and in heaps of coconut leaves and husks. The egg stage covers about 12 days. The resulting grubs feed entirely upon dead vegetable matter of this nature and never attack healthy coconut palms. The duration of the larval stage is long, roughly five to six months. The subsequent pupal stage occupies five to six weeks. The life cycle, from egg to adult, therefore occupies about seven months. The damage to the coconut palms is due only to the adult beetles, not to the larvæ. The beetle are entirely nocturnal in their habits and are frequently attracted at night to lights in houses and on ships in port. (I have seen many beetles of a closely allied species at night in an hotel near the wharf at Samarai, New Guinea, and also occasionally in hotels in Java and Malaya.) The beetle feeds by boring into the head of a coconut palm, often cutting off the tops of young unopened leaves in the central shoot or "cabbage," and sometimes killing the tree outright. It never attacks opened leaves. On account of its large size, a single beetle can do a great deal of damage. The adult insect feeds not only upon coconuts but also on many other species of palms and it has even been reported to attack sugar cane. It probably lives for several weeks when an abundant food supply is available, and would certainly survive for several days without food.

6. It is clear that the insect might be brought to Fiji in the egg, larval, or pupal stage in vegetable matter, and it is very doubtful whether it would be destroyed by fumigation. It is therefore essential that all cargo and baggage from Samoa should be inspected extremely thoroughly on landing in Fiji. The importation of the early stages of the pest can be prevented in this way, but the possibility of the importation of the adult beetles remains, and is not so easy to eliminate. It is almost certain that the beetles occasionally fly to lights on board ships in Samoa, and it therefore seems probable that they are occasionally brought to Fiji, and will eventually become established unless every precaution is taken. It is impossible completely to eliminate the possibility of importing the adult beetles except by preventing ships from staying in port overnight, a measure which is probably too drastic to be justified; but if such ships were prevented from remaining alongside the wharf overnight, it is most unlikely that any beetles would fly ashore, partly on account of the lights on board and partly because there would be no palms sufficiently near to attract them. As a further precaution, I consider that all palms growing near the wharf should be cut down and that the accumulation of dead vegetable matter in the vicinity of the wharf should be reduced to an absolute minimum. The removal of all palms near the wharf would be fully justified in this connection, as a precaution not only against Rhinoceros Beetle, but also against other coconut pests.

THE EXTERMINATION OF THE RAT.

By H. R. SURRIDGE, A.R.C.Sc.(I), Government Agronomist.

IN view of the serious damage caused by the destruction of young nuts in our coconut plantations by rats and the damage to foodstuffs in houses, general stores, &c., a resumé of the various methods of control adopted in other countries should be of service to those interested in the extermination of this serious pest here in Fiji.

The literature on this subject is continually being added to, and the general public are gradually becoming aware of the seriousness of the rat menace to human life, health, and prosperity. That it is a menace to our lives is demonstrated by the tremendous loss of life in historical times in England, Europe and other countries, and at the present time in India, through the Bubonic plague. Health is endangered through the contamination of foodstuffs, whereby the minute organisms causing various diseases are passed on to us, *e.g.*, trichinosis, tapeworm, parasitic mange, and trypanosomiasis (sleeping sickness).

Some authorities consider that dengue fever is distributed by the rat. It is certain that in some rat infested areas, notably in Athens (Greece), dengue is prevalent, whilst it is unknown in the clean areas. The same has also been noted in Natal, South Africa.

Prosperity is affected by the loss of foodstuffs destroyed and damaged by this pest, and by the damage to buildings, dams, ropes, &c., which, while apparently small, is not appreciated until a dam or a rope suddenly collapses, with possible loss of life. Owing to the general character of such damage, it is not apparent to the public. Merchants, in assessing their profits, realise that a considerable loss is due to rats, and so regulate their prices as to cover such losses. This might be termed "the indirect taxation by the rat," since the levy of the rat is passed on to an unsuspecting and unthinking public. If such losses could be obviated by the extermination of rats and mice, the general cost of living would be somewhat reduced, the people's health safeguarded, and the risks of epidemics minimised.

Consideration of the three points just briefly discussed shows that the activities of the rat spell loss of life, health and money to the human race.

History.—The rat, like the poor, is "with us always," and according to historical records, has always been with us, and always as a menace. In ancient Egypt its destructiveness to foodstuffs was such that the Egyptians, appreciating the cat as a natural protector of grain or foodstuffs against the depredations of rats and mice, deified the Cat and worshipped it accordingly. Most of the plagues of history, which have caused grave loss of human life, can be traced to the rat as the carrier and distributor of the fatal bacillus, the most common being the famous "Black death" or "Bubonic plague" bacillus. With such a record, the slogan should be "kill that rat."

Varieties.—The varieties of rat most common in these islands are:—

- (a) The Brown or Hanoverian rat (*Rattus norvegicus*), probably brought here by ships, either to the various ports, or when such vessels have been wrecked and cast ashore.
- (b) The Alexandrian rat, (*Rattus alexandrinus*), the fur of which is longer and lighter in colour than in the case of the brown rat.

Mice are just as obnoxious as rats, but as they are smaller and not so fierce, the danger through food contamination by them is apt to be forgotten.

Legislation.—In Great Britain and other countries, legislation has been enforced, making it an offence to harbour rats or mice on one's premises, and fines are imposed on those contravening the law. Local authorities and the Ministry of Agriculture in Great Britain organise annually what is termed "rat week." This is one week of the year set aside for rat destruction, and the time chosen is that when the rat migrates from the field to the houses, buildings, towns, &c. In cold countries such migratory movements occur, there being two periods in the year for the rat. The first is early in spring when the migration is from the towns, houses, &c., to the field, the second in late autumn when the reverse movement occurs.

Here in Fiji, owing to climatic conditions, there is no clear differentiation between summer and winter, with the result that no migratory movements, similar to those of cold countries appear to occur. It has been noted however, in coconut plantations, that rat damage appears to be more intense during the dry season than during the wet season, thereby suggesting that a certain amount of migration from the ground to the trees and vice versa occurs between the two seasons. Whether there is actually a definite migration at a more or less definite time has not yet been noted. This matter requires investigation, for if such a movement does occur, then the knowledge of it would assist the institution of measures of control.

Control Measures.—Measures of control are not easy to suggest, since many that are suggested are also fatal to human beings, domestic animals and birds. Therefore, in considering control measures, it is necessary to devise means which, if possible, are fatal to the enemy only. Roughly there are four possible measures of control, three which are more or less in common practice, and one which while the ideal method, has not yet been perfected. The methods in use are as follows:—(1) natural enemies, (2) trapping, (3) virus, (4) poisons.

(1) *Natural Enemies.*—These include dogs, cats, mongoose, owls, the kestrel, magpies, snakes, and last but not least, the rat itself. Most of us are familiar with the dog, cat, mongoose, &c., as rat destroyers, but few appreciate the use which can be made of the male rat as an exterminator of his own kind.

Of the natural enemies named, the mongoose, in Fiji, is perhaps the least appreciated, owing to its habit of apparently preferring one's poultry to rats. It is possible however to utilise the mongoose in islands where rats are prevalent, but to which the mongoose has not been introduced. This may be accomplished by the expedient of trapping the mongoose, retaining the males and liberating them (males only) on those islands at present suffering from the pest. Such a scheme should result in the destruction of the rats, and the ultimate death of the mongoose. To attain such an end, it should be possible to breed the mongoose in captivity, to secure the males required.

Our experience with owls is limited, but given the right breed of owl, once these are established, they will exercise wonderful control over the rat. Mr. Moore Hogarth, in his book, *The Rat—A World Menace*, gives an instance where an owl with young had destroyed, in one night, 19 young rats and 27 mice as well as other vermin.

The kestrel and the magpie also account for a considerable number of these vermin, whilst certain snakes, harmless to human beings, are excellent in cleaning up rat infested areas. It is unfortunate that here in Fiji such snakes are rare, owing it is believed, to the activities of the mongoose.

Finally, there is the rat itself to be considered as its own exterminator. Two methods are possible, and these can be combined to form a very useful and effective measure of control.

The Rodier Method named after its inventor, an Australian, Mr. W. Rodier, is briefly to catch the rats alive, destroy the females, release the males, recording the number of females destroyed, and for the purpose of identification, cutting off half the tail of each male rat released.

The theory of this method is that under normal conditions the rats live in a polygamous state, which condition is conducive to prolific reproduction. Releasing the males and destroying the females tends to bring about a monogamous state, which state tends to restrict reproduction, by the males harassing the females, breaking up the nests, and destroying the young. Therefore the greater the number of males the quicker the extermination of the rat.

The second method is to foster the male rat's cannibalistic tendencies. Catch the rats alive, as previously suggested, but before releasing the males, half starve them, and then feed them with rat flesh. After a few days on this diet, release them. Such rats will prefer rat flesh to other foodstuffs with the result that they will fiercely raid the nests and destroy the young, as well as destroy the young rats that have already left the nest.

This latter method has been tried out by the writer, in the neighbourhood of farm buildings, with good results. It has also been stated to be effective on ships (ref.: *The Rat—A World Menace*, page 95).

(2) *Trapping*.—This can be accomplished by using the ordinary wire traps, for live catching, or the popular "break back," the rat-gin, &c. Two very useful traps which can be made at home are—

- (a) sink a barrel, cover the top with strong paper and place bait in the centre of the paper for three or four nights. Then slit the paper in the shape of a cross, place as usual. The rats in getting at the bait will fall into the barrel;
- (b) partly fill a bucket with water, and then fill up with corks to about 4 or 5 corks deep. This, placed between the rats and the bait, will compel the rats to cross the bucket, so that the corks will take the first weight of the rat but not the full weight, with the result that the rat falls through the corks and is drowned.

Another type of trap, which however is expensive, is made by using "Rat-lime" or a similar preparation. This is spread on a board, the bait being placed in the centre, or possibly the lime could be spread around the trunks of trees, one-eighth of an inch thick and about a foot wide. The rats in trying to get to the bait get stuck in the lime, and in struggling to free themselves get the nose or mouth embedded in the mixture and are suffocated.

(3) *Virus*.—The use of a contagious virus is probably the ideal method of rat extermination. Unfortunately, no virus preparation has yet been found which will automatically destroy the rat and not infect other animals including human beings.

Various preparations are on the market, which contain a virus and a poison so that their efficiency is probably due more to the poison than to the bacillus included in the preparation.

(4) *Poison Baits*.—Various poisons can be made use of, but the difficulty, when setting poisoned baits in the field or elsewhere, is to ensure that domestic and other animals will not get those baits, with fatal results. Two substances are in favour, one, Barium Carbonate, which is poisonous to rats, human beings and animals generally, the other, Red Squill Powder, which appears to be fatal *only* to rats, domestic animals and others not being affected by the amounts used.

(1) *Barium Carbonate*.—This is one of the most efficient of poisons, provided it is mixed with the right base. The British Ministry of Agriculture recommend a one-in-four mixture. Some maintain that a one-in-seven is strong enough. Barium Carbonate is a heavy white powder, mildly poisonous, tasteless, odourless, slow in action and inexpensive. While poisonous to rats, it is also poisonous to other animals so that great care must be exercised when distributing the baits.

To prepare the baits, all the ingredients must be thoroughly mixed, and if the baiting is done during dry weather, add sufficient water to make the baits rather mushy, since such baits are more attractive to the rat, particularly when water is not readily available. A variety of baits, used separately, gives the rat a free choice and enhances the chances of the baits being taken.

When mixing or laying baits, it is useful to keep the hands oiled with coconut oil, rancid if possible, since this will help to disguise the human smell, and help to allay the suspicions of the rat.

The following recipes will be found useful:—

(a) Barium Carb.: (commercial)	5 parts by weight.
Flour	2 parts by weight.
Cheese	10 parts by weight.
Glycerine	3 parts by weight.

Thoroughly mix and then make into a stiff dough, roll out on a pastry board and cut into squares, making 1,400 tablets for each 1 lb. of Bar.: Carb.: used. Bake lightly and sprinkle with flour flavoured with aniseed.

(b) Barium Carb.:	1 part.
Flour	3 parts.
(c) Barium Carb.:	6 oz.
Meal (any corn meal will do)	16 oz.
Dripping	4 oz.
Salt	$\frac{1}{2}$ oz.

Mix thoroughly. This quantity should give about 1,000 baits, about the size of a hazel nut. Sufficient oil of aniseed or coconut oil should be used to give the necessary odour.

(2) *Red Squill Powder*.—This is harmless in the quantities used, to most animals—rats excepted. The chief objection to squill is that it has no uniform toxic standard, so that the commercial product is apt to vary in its efficiency. It is important therefore that the purchaser should secure from the manufacturer or his agent, a guarantee as to the efficacy of that particular product.

In preparing red squill baits, however, with commercial red squill powder it is fairly safe to mix thoroughly 1 part by weight of squill powder to 10 parts by weight of any cereal meal, or peanut meal. Further, squill powder has the advantage of being effective in a dry mixture, and in such a case should keep in good condition for a considerable time.

- Red squill powder, 1 part by weight; flour, 4 parts by weight. Mix into a stiff dough with water; roll out and cut into biscuits, making 700 biscuits for each $\frac{1}{2}$ lb. of squill powder used. This gives about 5 grs. to each biscuit. This form of bait keeps good a long time.
- Red squill powder, 2 parts; finely chopped bacon, 3 parts; meal enough to make into a coherent mass, then bake in small cakes.
- Red squill powder can be dusted on fruit, for example, 1 oz. will be enough to sprinkle 3 bananas sliced into 48 pieces, that is 16 pieces to each banana.

Other poison baits, such as arsenical compounds, strychnine, phosphorous, &c., can also be used, but these are very deadly to stock and human beings.

Laying of Baits.—Before poisoned baits are laid, it is advisable to use non-poisoned baits for the first 3 or 4 nights, to get the rats accustomed to the new diet, and then lay the poisoned baits, using an excess number of baits to secure the greatest kill. A fortnight at least should elapse before using baits a second time in one place. Baits should be laid in the evening, and those remaining should be gathered up next morning. In this way a record is obtained of possible casualties, and reliable knowledge gained of the effectiveness of any one kind of bait.

Procedure.—For the plantation, as well as the town, there is only one successful way of tackling the rat pest, and that is by continuous consistent effort on a co-operative basis. Obviously the individual planter cannot meet with success, single handed, except perhaps in the application of the Rodier method. In England and on the continent of Europe, societies or clubs exist for the destruction of these vermin. Such a scheme could be applied here through the various Progress Associations that exist in these islands.

To summarise, there are four main methods of control:—(1) natural enemies, (2) trapping, (3) virus, (4) poison baits.

No one method is perfect, so that a combination of methods is essential. To ensure that these methods have their quota of success, co-operation between the people of any island or district is essential, otherwise the individual who is endeavouring to rid his place of the pest is continually being reinfected from his neighbours' premises. Whatever measures are adopted must be applied continuously and consistently until the pest has been exterminated.

In all cases it is advisable to prebait for a few nights, and then apply the traps and/or baits to secure as large a bag as possible. Allow intervals of about a fortnight to elapse before repeating the attack. Finally, keep a record of all casualties as suggested by the number of baits taken, so that definite knowledge may be obtained of the effectiveness of the system in operation for the expenditure involved.

Amongst the various publications dealing with the rat pest, the book *The Rat—A World Menace*, by Mr. Moore Hogarth, published by John Bale, Sons, and Danielsson, Ltd. London, price 7s. 6d., will be found useful to those interested in the destruction of vermin.

SPECIMENS FOR IDENTIFICATION.

By H. R. SURRIDGE, A.R.C.Sc.(I)., Government Agronomist.

ONE important function of the Department of Agriculture in a Colony such as Fiji is the identification of various botanical and zoological specimens, which from time to time are sent in by various interested people, the interest being aroused mainly through the specimen causing damage to their crops, live stock, buildings, &c., In view of the increasing number of such specimens received in Suva, and the importance of making as rapid an identification as possible, it is not out of place to publish a few simple directions as to how to collect, prepare and forward such material to the Department of Agriculture.

(1) BOTANICAL SPECIMENS.

Collection.—The great aim to be kept in view in collecting is to obtain as perfect and comprehensive a specimen as possible; that is one showing every part of the plant, root, leaves, flowers, and fruit. It is not always possible to show all these details on the one specimen, in which case several would be required to cover these essential features.

Where it is not practical, from its size, to collect the whole plant, the leaves from the root, stem or lateral branches should be taken, and the flowers collected. It is necessary to ensure that all types of flowers from the one plant, shrub, or tree are forwarded, owing, as in the case of the coconut, to two different types of flowers—male and female—being carried on the same tree, or as in other cases, on different trees.

Specimens should be forwarded in duplicate, if possible in triplicate, since it is sometimes necessary to send specimens away for identification, in which case, one can be retained here for future reference. All possible information should be given as to where the plant is found, the type of soil favoured, whether it grows in the wet or dry zone, the season of flowering, whether annual, biennial, or perennial, or other peculiarities or points of interest noted; in short, the plant's history as known to the collector.

Preparation.—Lay the specimen, if possible, between sheets of paper, and when ready for despatch, tie in a parcel stiffening the parcel by backing it with a piece of thin wood or similar material. This will minimise risk of damage in transit.

Diseased Specimens.—When diseased specimens are being forwarded for the purpose of diagnosis, they should be carefully wrapped up, and if of considerable size, wrapped in sacking or similar material so that during transit to Suva no part may be lost, and the plant, leaf, or whatever section is forwarded for examination, may be received as near to its original condition as possible with the diseased parts showing clearly. This will facilitate identification. As a case in point: a coconut leaf was recently received at this office, it had been cut off the tree, carried at least a quarter of a mile through the street, on a man's shoulder, waving in the breeze. On arrival it was thrown down on to the floor of the verandah, and the writer asked to diagnose the injury. Owing to the method of transport and manner of delivery, no insect life was visible, an important omission in this case, because the damage to the leaf suggested the presence of insects, one of which was the dreaded Levuana moth. Had this leaf been carefully taken down, the leaflets tied to the midrib, and the whole carefully despatched to the office, the larvæ or the adult insect would probably have been found and so the cause of the damage attributed to the moth *Agonoxena* would have received confirmation on finding the insect present. Since the damage done by the moth *Agonoxena* can be confused with that caused by the Levuana moth, this example demonstrates that care is essential when forwarding specimens for identification.

(2) ZOOLOGICAL SPECIMENS.

Collection.—In collecting these specimens, particularly the various insects, &c., which damage our crops, every endeavour should be made to capture them alive and in the act of committing the damage complained of. From purely a collector's point of view, it is of interest to know on what an insect feeds, and to work out its life history. From an economic point of view, it is essential to know on what an insect feeds, at what particular stage in its life history it does the most damage, and is the most susceptible to measures of control.

Preparation.—In forwarding such specimens, it is as well to include plenty of foodstuff to last out the journey and allow for a surplus to carry on with on arrival in Suva. When the specimen is small, the usual tobacco tin will be found very useful to send it in, while the larger specimens a wooden box or a cardboard carton would serve. In many cases it is sufficient to secure plenty of food material, and carefully wrap with sacking when forwarding to Suva. In all cases, however, all possible information should be given to facilitate identification.

When forwarding moths, butterflies, beetles, &c., lay them in tissue paper or similar material, to prevent movement during transit and to ensure reasonable condition on arrival. Here again the tobacco tin, match box or other receptacle, according to size, is of service.

It is essential that all receptacles used for sending insects to Suva should be absolutely ant-proof, or else that some deterrent, such as carbolic acid, should be enclosed with the specimens. Napthalene is useless for this purpose.

All specimens, botanical or zoological, should be addressed to the Director of Agriculture, Suva, and marked "Specimens Urgent."

THE FRUIT FLY.*

It is greatly to be deplored that the Mediterranean fruit fly should have recently made its appearance within the borders of the United States of America—an invasion that again brings to the fore the very important questions relating to the introduction of new pests into countries, and to the efficiency of the methods of preventive inspection and quarantine legislation at present in vogue and which concern nearly all the agricultural departments in the world. The rapidity with which the fly has spread from its supposed original home—the Mediterranean countries, the havoc which it has caused on its trail through Bermuda, Hawaii and the Azores, where it has destroyed important fruit industries, the difficulties which it has given to fruit growers in Spain, Italy, South Africa and Australia, all have been sufficient warnings to Americans of the very great dangers fraught with this pest, and of the necessity of keeping it out of their own country. And yet, their very laudable efforts in setting up elaborate and costly machinery to prevent such an invasion have signally failed and it is now feared that if this fly is not exterminated it will spread in the southern states and become a serious menace to the great fruitgrowing districts throughout the warmer regions from the Atlantic to the Pacific coast. Such a state of affairs leads us to discuss briefly some views on the fly itself and of the ways and means by which noxious insects can be spread and be prevented from spreading.

The Mediterranean fruit fly which is undoubtedly one of the most dreaded and destructive fruit pests in the world, was first recorded in American regions when it invaded the Bermuda Islands shortly after the middle of the last century, and again about 1910, in the Hawaiian Islands. Fortunately for the West Indies and Central America, it has not yet, to our knowledge, found its way there, although it is now distributed throughout the tropical and sub-tropical parts of the world. Its foods include a wide range of fruits and vegetables and the damage is caused by the maggots

* From *Tropical Agriculture*, Sept., 1929.

which hatch and feed within the ripening fruit, thus spoiling it for the market and often rendering it totally unfit for human consumption. When it became known in April last that the fly had been discovered and identified in Florida, the United States Government and the Government of the State of Florida immediately put forward a most energetic campaign. Funds were provided by the Governor of the State and the President of the Nation, and inspection and clearing up services started in an attempt to eradicate the pest before it should spread beyond the limits of the 80 square miles which were at first found to be infested.

It is from about 1910 that the United States Government has maintained a quarantine inspection service at all ports of entry and frontier points. Fruit flies, the Mediterranean and others, and several species of insects, as well as diseased plant material are intercepted in commercial cargoes, in passengers' luggage, and even in their pockets. Reference to quarantine reports will show that thousands of interceptions are made each year, and whilst many of these are well known pests and diseases, others are insects and fungi which might become of economic importance. Although the American preventive inspection and quarantine service has been remarkably efficient it has not always, unfortunately, proved absolutely infallible. Before it was established, the country had been invaded by the Mexican cotton boll weevil, the San José scale, the Gipsy Moth and other pests of primary importance, but even since the existence of this service, pests which may prove of equal importance have found their way in and amongst these must be mentioned the pink bollworm, the Japanese beetle and the European corn borer. The European corn borer is already invading the great corn belt, the Japanese beetle is thoroughly established in certain eastern localities while in the case of the pink bollworm of cotton, hope is still expressed that the pest may be exterminated.

There are very few countries now which do not harbour some important pest which has been introduced through the ordinary channels of commerce and although routine methods of transmission in cargo or passengers' luggage are well understood, and can be reasonably controlled it is not so easy to guard against unforeseen methods of ingress. The introduction of insect pests has often been shown to be due either to the carelessness of those who should have been better informed or to complete ignorance, as some of the following examples will show. A few years ago, at the San Francisco Exhibition, samples of cotton from China were shown which were found to be infested with the pink bollworm and indeed proved to be the first record of the occurrence of this insect in that part of the world. In California a law prohibiting the importation of live insects into the State was unintentionally violated by somebody sending a parcel from Kansas containing living grasshoppers which were to be used in trick photography. The collection of souvenirs consisting of twigs and fruits is another way by which pests are scattered and this method is often in evidence in the small West Indian Islands, where tourists take cotton bolls, fruits, pods or leafy twigs in one place only to discard them the next day in a shrivelled condition in another colony. It is not known how the Mediterranean fruit fly entered the United States, but it is probable that something unforeseen gave the insect its chance to establish itself.

The Mexican fruit fly or Orange worm is another pest against which an intensive quarantine inspection has been maintained. This insect, also, got past the quarantine barrier early in 1927 and has caused a short war of extermination on a restricted area in Texas. This seems to have been

successful for although the insect is commonly to be seen in the market of Matamoros in Mexico, it has not been recorded on the Texan side of the Rio Grande for about two years.

The greatest danger in the distribution of crop pests and diseases undoubtedly lies in the rapid growth of modern transport facilities which bring with them an increasing number of cargoes and passengers—both potential sources of infection. To this must be added the fact that the balance of nature has been considerably disturbed through the opening and planting up of virgin areas which are fresh ground for the successful development of certain insects. With the help of trade the latter have in turn been exported from their native haunts to new localities, where, no longer under the control of their natural enemies they have done irreparable damage. In fact, the further the problem is studied the more complicated it becomes and the more difficult it will be to find successful means of controlling known pests. The war with insects which began with civilization can never cease and in future only partial control can be hoped for. At present such control consists of the use of poisons, the encouragement of natural enemies, the development of immune or resistant strains of plants and an understanding of the relation of plants in good health to immunity from attacks from certain types of insects. All, although they are not absolute means of control, have their value, but often some trivial and entirely unsuspected circumstances may give an opportunity for invasion, even with the best inspection service. As civilization further progresses the problems to be tackled by entomologists will become more and more intricate but this should not deter the layman from doing his share by studying when he can those pests which may well become a very great danger to the community of which he is a member.

FRUIT FLY CONTROL.

Among the fruit flies, the chief offender in Fiji is *Dacus passifloræ*. Although Fiji is specially suited for biological methods of control I do not recommend them in this case. Chemical methods (spraying and poison baits) are practicable, but would require very careful organisation on a large scale if they are ever to be effective.

The greatest difficulty is the abundance throughout Fiji of guavas and other native fruits in which the fruit flies breed, and unless these were tackled at the same time as cultivated areas, very little good would result. At the present time, the growing of citrus fruits in Fiji is a very casual haphazard business, and in such circumstances control measures are not worth while. Even if they were begun in a proper manner they would not be maintained with sufficient regularity to be effective.

If, however, extensive cultivation of citrus fruits is contemplated, a campaign against fruit flies would be well worth while. It would be possible and practicable to reduce the quantity of fruit flies very greatly by chemical means if the areas under citrus were large and well cared for. In such circumstances I would recommend the use of poisoned baits (rather than spraying) in conjunction with the destruction of all wild fruit trees in the neighbourhood.

BALED COPRA.*

By C. D. V. GEORGI, Acting Agricultural Chemist, and F. C. COOKE,
Assistant Chemist for Copra Investigations.

INTRODUCTION.

THE usual method of packing copra is to suspend an open sack from the roof of the copra store and to compress the contents by means of heavy poles used as rams. By this method two coolies can fill ten bags, each containing a picul of copra in one hour. For shipment to Europe, new bags costing 50 cents each are frequently employed, having a capacity of between 133 lb and 2 cwt., while second-hand bags are almost invariably used for the local sale of copra.

THE PROPOSAL TO BALE COPRA

It has been suggested that the effective space, occupied on ships and in godowns by a ton of copra, can be reduced, and pilferage controlled by packing well-dried, good quality copra in the form of compressed, oblong blocks of uniform size and shape, and weighing two cwt. each. Such bales can be handled, stacked and checked easily and well, and, provided that the moisture content of the material was less than 7 per cent. resistance to mould growth, to the development of acid and rancidity and to insect attack would possibly be greater than when copra is packed in sacks.

DESCRIPTION OF PLANT AND PROGRESS.

As is the usual practice with "mixed" copra for export, the copra is first sorted to remove bad pieces of "F.M." (fair-merchantable) quality. The good copra of F.M.S. (fair-merchantable, sun dried) quality is chopped by women to give eight pieces per nut. This sizing, which assists compression of the bale and ensures a cohesive block, could alternatively be done in a turnip cutter.

The practice of chopping after drying is already practised on some estates, and serves to ensure a product of uniform and convenient size; to improve the appearance of the copra; to prevent the accidental inclusion of dirt, foreign matter and pieces of second quality copra; to assist further drying; and also to ensure that the copra makes a close and tight pack. On the other hand it might be better to chop the copra in the half dried condition, when it is being removed from the shell; if this is done, the cut surfaces will seal up in later stages of drying and the rate of drying will be further accelerated and more uniform drying assured.

The following is a description of a baling press which is in operation in Selangor:—

The baling machine consists essentially of a long steel box 4 feet high, with two fixed sides and two hinged sides, and capable of being swung as a whole on a vertical shaft. All the sides are reinforced by strengthening girders, and secured in position by a rapid acting clamping device. The top and bottom of this box consists of two removable, grooved, wooden plates or "platens," strengthened and backed with steel, and making a close, sliding fit with the vertical sides. These "platens" are removed from the machine, and two new pieces of Hessian cloth (40 ft. by 48 in. which will

* Extract from *The Malayan Agricultural Journal*, Vol. XVIII, No. 6, June, 1930.

ultimately cover the bale are laid over them, and secured in position. The top "platen" is then fitted to the underside of a stout cross-arm, supported on two vertical joists immediately over the hydraulic ram-head; and the bottom plate is placed in position in a recess at the bottom of the box which is thereupon closed securely by the clamps.

The power to work the hydraulic ram is obtained from a 10 h.p. Tangye engine through a counter shaft, the pressure being applied and controlled by a simple arrangement of levers.

Two cwt. of the chopped copra are emptied into the box and levelled up. The filled box is then swung smoothly into position over the ram head and immediately under the top "platen" suspended from the cross-arm. A pressure of 28 tons is slowly applied, until the copra ceases to compress, through the ram-head to the underside of the lower "platen," the area of which is 384 square inches. The effective pressure on the copra during a compression period lasting 40 seconds, is thus 1.5 cwt. per square inch.

When the limit of compression at this pressure has been reached, the ram is locked in this top position, and the clamps securing the box quickly released. The whole cage then swings clear of the bale, back to its original position where it is recharged. The bale remains held in position between the two "platens" by the locked ram-head, and the copra is thus exposed to view, a solid oblong block, with not a trace of oil exuding from it. The Hessian cloths are loosened from the "platens" and roughly "stabbed" into position over the block of copra. Three "safe-seal" wires are next passed through the grooves in the "platens" so as to encircle the bale and they are separately tightened and sealed by a portable "Griplock" sealing machine. The ram is now released, and the bale trucked away for sewing.

WORKING DETAILS.

	Baling process.	Bagging process.
Maximum throughput of process	17 bales per hour or 34 cwt. per hour.	10 bags per hour or 12 cwt. per hour.
Time for one complete bale or bag	6 minutes	6 minutes.
Weight of packing	4 lb to 2 cwt. of copra	2 lb to 1 picul of copra (equivalent to 4 lb to 2½ cwt.).
Cost of packing materials . .	45 cents a bale or 23 cents a cwt.	50 cents a bag or 38 cents a cwt.
Pressure applied at ram	=28 tons.	....
Pressure on the bale	=1.5 cwt. per square inch.	....

It is not possible to give details of the labour requirements until the present plant is on a full-time regular production.

THE BALE.

The finished bale is a very neat oblong block of a convenient size and shape to handle. Four pieces of split bamboo which are inserted with the Hessian cloth under the wires, serve to keep the bale rigid and compact, and prevent the wire cutting into the copra and so loosening during the vibrations of transport.

The volume occupied by the two cwt. of baled copra is under 5.3 cubic feet, as against 8.3 cubic feet for the same weight of copra in sacks and the overall dimensions of the bale are 25½ in. by 17 in. by 21 in. The bales pack very neatly and squarely; 84 bales arranged in a stack, 7 high, 4 wide, and 3 deep, occupy 49 cubic feet (12 ft. 7 in. by 9 ft. 3 in. by 4 ft. 2 in.). Thus the "broken stowage" for 100 bales (10 tons 4 cwt. in weight with packing)

will be 58 cubic feet. At present, because it is a bulky commodity, 12 cwt. of bagged copra are charged freight, as though they weighed a ton, whereas if the copra were baled, a ton of copra could be freighted as such without correction, and 8 cwt. stowage could be saved.

POSSIBLE OIL LOSS DURING BALING AND SHIPMENT.

(a) *By compression.*—Although the pressure is gradually applied to the loose copra and is only of 40 seconds duration, it might be thought that oil would be lost. There is, however, no sign of loss of oil, nor darkening of the floor immediately underneath the press, and if the hand is rubbed over the exposed block of compressed copra, it will be found to show no trace of exuded oil.

The bale of copra is wired and left in compression, so that the pressure is maintained, until the block is broken up. It could be argued, therefore, that the vibrations and shocks of transport might cause oil to exude and be absorbed in the Hessian covering material. There is, however, no loss of oil on this account.

(b) *By self-heating.*—In a single bale of copra, the facilities for heat escape may be worse than from the centre of a bag of loose copra. It is almost certain however that a stack of bales is better ventilated than a stack of bags because of the straight channels and connected air gaps which must separate each bale and allow free passage of the cooling air. In a heap of bags, the air spaces which exist inside are generally sealed at some point by the weight of superimposed copra.

When copra deteriorates, heat is liberated and, under the conditions existing in a stack of sacks in the hold of a ship, is accumulated to the further detriment of the copra and the production of free acidity, moisture, colour and rancidity with loss of oil.

It will be seen, later, that in the trial shipment of good baked copra, no oil loss whatsoever has occurred, and that the free acid formation is somewhat less than the average for sacked Malayan copra of good quality.

CONTROL ANALYSIS OF A TRIAL SHIPMENT OF COPRA.

A small quantity of copra was taken from each bagful of a large consignment of copra, prior to baling. This total sample weighing about 360 lb was then well mixed, spread evenly on the floor, and the pile divided into four quarters. The copra from two diagonally opposite quarters was taken for pressing into a sample control bale, to be kept in the store shed of the Department of Agriculture, and the copra of the remaining two quarters was then "quartered down" until only 10 lb was left. From this small amount, three samples were drawn for determination of the percentages of moisture and oil in the copra, and of the acidity of the cold expressed oil. The loose copra still remaining was then placed in a sack and stored under the same conditions as the control bale. The results of the analysis, and the appearance of the copra indicate that the copra was of normal good F.M.S. quality.

ANALYSIS PRIOR TO DESPATCH.

Test.	Sample. No. 1.	Sample. No. 2.	Sample. No. 3.	Average.
Moisture per cent.	6.8	6.7	6.7	6.8
Oil per cent. (wet basis, copra as received)	60.1	60.9	60.6	60.6
Oil per cent. (dry basis) . . .	64.6	65.3	65.0	65.0
Acidity per cent. (as lauric acid) . . .	.65	.74	..	.70

The main consignment of bales was despatched to Europe and two months later the control bale and sack of copra stored at the Department of Agriculture were re-weighed and tested with the following results:—

ANALYSIS AFTER TWO MONTHS.

Loss in Weight.

Pack.	Nett weight, June 25th.	Nett weight, August 27th.	Per cent. loss in weight.
Bale	229 lb.	224 lb.	2.2
Sack	113 lb.	111½ lb.	1.3

Acidity of the Cold Expressed Oil (as Lauric Acid).

Sample taken from	Date.	Acidity per cent.
Loose copra before baling	June 27	.. .70
Copra from centre of bale .. ..	.. ..	1.72—Aver. 1.44
Copra from outside of bale	Aug. 25	1.16—
Copra from sack	Aug. 27	.. 1.43

There was little evidence in either case of mould growth, although in both cases the copra had been attacked by a variety of insects. The stored bale showed no signs of oil exudation, nor were there any indications of the copra becoming self-heated by deterioration in the absence of freely moving cooling air within the bale.

The main consignment of this copra, despatched to Europe in baled form, arrived at its destination in August, where it was analysed both by the consignees (c) and also by an independent arbitrator (a).

COMPARATIVE RECORD OF ANALYSIS.

Total Oil Content before and after shipment.

	Weight. Cwt.	Oil per cent. (Wet basis).	Total oil. Cwt.
Loose copra before baling	1,904½	60.6	1,152
The same copra as received in baled form in Europe (C)	1,845½	62.8	1,158
.. .. (A)	1,845½	64.0	1,180

Quality.

Sample taken from	Moisture per cent.	Oil per cent. (Dry basis).	Acidity per cent.
Loose copra before baling	6.8	65.0	.70
Stored in Malaya (baled) .. ..	..	..	1.44
.. .. (sacked) .. ..	..	..	1.43
Baled copra as delivered .. (C)	4.5	65.8	1.51
.. .. (A)	4.6	67.2	1.48

Per cent. Loss in Weight in two Months.

Circumstances.	Loss in weight. per cent.
During storage in Malaya—as a single bale	2.1
Do. as a single sack	1.3
During shipment to Europe in baled form	3.0

From the above it will be seen that the copra does not lose oil during baling or subsequently during shipment and storage. The slight differences in the calculated amount of total oil are within the limits of experimental error if consideration is allowed for possible differences of method, and for personal error.

The acidity of the oil was determined here on the cold expressed oil and not on the oil extracted by solvents, the latter giving slightly lower results. It would appear that, in spite of the cooler conditions on the way to Europe, the stacked bales deteriorated slightly more than the solitary control bale kept at the Department of Agriculture, whilst the loss in weight was also greater, though of course the conditions of storage were very dissimilar.

THE DETERIORATION OF STRAITS F.M.S. COPRA DURING SHIPMENT
IN SACKS TO EUROPE.

Eighteen large samples of F.M.S. copra from various estates in Malaya gave the following results on analysis:—

Moisture per cent.			Oil per cent. (dry basis).			Acidity per cent.		
Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.
6.9	9.1	4.7	65.9	69.0	62.2	.18	1.00	.03

Seventeen different bulk consignments of Straits F.M.S. copra, received in Europe in sacks, yielded the following figures from the analysis of the consignees:—

Moisture per cent.			Oil per cent. (dry basis).			Acidity per cent.		
Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.
4.7	5.5	3.9	65.0	67.0	63.6	2.25	5.06	.35

It will be seen that the average acidity has increased from .18 per cent. to 2.25 per cent. for copra in sacks, whereas the trial shipment of baled copra only increased in acidity from .7 per cent. to 1.5 per cent. The loss of moisture for copra in bales and in sacks, is however, identical.

CONCLUSIONS.

1. There is no indication of loss of oil during or after baling when the copra is properly dried, is of genuine F.M.S. quality and is packed cold.
2. There is no evidence that the copra deteriorates more when in the form of compressed blocks, than it does when stored in sacks, in fact there are indications to the contrary.
3. The system of chopping before baling will ensure product of uniform and convenient size which will be easy to handle by the crushers, and will also prevent the accidental inclusion of dirt and foreign matter by the producer.
4. Baled copra is convenient for handling, stacking and checking.
5. The trial shipment arrived in Europe "intact and in good order."
6. The effective space occupied by copra in baled form is one-third less than when stacked in sacks.
7. In conclusion, the writers wish to record their thanks to Mr. F. W. Douglas for technical assistance in this inquiry; also to Mr. Gunn Lay Teik for carrying out the analytical work.

The dollars quoted in this article are Straits Settlements currency \$1=100 cents=2s. 4d. Also 1 picul=100 katis=113½ lb.

For explanation of the significance of oil per cent. (wet basis) and oil per cent. (dry basis) see *Malayan Agricultural Journal*, Vol. XVII, Sept., 1929, No. 9.

MAIZE.

AUCKLAND merchants object to Fijian maize because of the presence of weevil in practically all consignments. This fault could be removed by fumigation, which is an expensive process, that could, however, be economically carried out prior to shipment. The only method of satisfactorily drying maize artificially is by dehydration, which shrinks the grain to such an extent that it is almost useless after treatment.

The present duty in New Zealand is 2s. per 100 lb plus 22½ per cent., with no primage; that is to say 2s. 6d. per cental.

April, May and June are the best months to ship maize from Fiji in order to reach the market before maize from South Africa arrives, which is generally about the end of June. Prices are usually steady during these months. The values during 1930 were from 6s. 6d. to 6s. 9d. a bushel. A good market exists in New Zealand for Fijian maize provided that the weevil can be eliminated before shipment and the grain is thoroughly dry and hardened.

(Note.—Duty of 2s. 6d. per cental is equivalent to 1s. 4½d. per bushel. Freight costs 55s. per ton, wharfage 1s. 10½d per ton, making total charges f.o.b. Suva to c.i.f. Auckland 2s. 9½d. per bushel, cartage extra).

Unless Fijian maize can be landed in New Zealand at very cheap rates it would be useless to export during the months of July to December. From December to July African and Java maize is imported in large quantities into New Zealand but only at such times when the locally grown maize is in short supply or is being sold at prohibitive prices. In New Zealand, African and Java maize is quoted c.i.f. at 160s. to 195s. equivalent to 4s. to 4s. 11d. per bushel. On August 6th, 1930, quotation for African importation, shipment *via* Australia was 151s. per ton c.i.f. & e., New Zealand ports.

One firm states that experience shows that a small, round, hard yellow maize sells better than the large horse-tooth variety. The maize trade in Auckland is amongst poultry keepers only who dislike large grain for feeding purposes. Small immature grain must always be excluded and good packing in clean once-used sacks, well sewn and branded, not exceeding 200 lb per sack nett will improve the selling value of the maize. The custom is to sell in 400 to 500 tons parcels.

In the earlier days of maize growing in the Bay of Plenty it was considered that shelling of the cobs should follow their storage for six to ten weeks in the crib, and it was seldom that a much longer period was allowed to elapse on most of the farms where the crop was grown. Consequently storage provision was often of a temporary nature, and as the practice of holding the crop for longer periods developed this storage was often quite inadequate, especially where crops were held for as long as twelve months.

Of the cribs built the most satisfactory for the smaller growers was the tapering (from top to base) form. Such a crib was usually 8 ft. to the eaves 5 ft. wide at the base, 7 ft. wide at the eaves, and varied in length, according to requirements, from 12 ft. to 25 ft. As the tapering sides were subjected to severe strains when the crib was filled it was found necessary to provide wall supports in the structure, spaced at 3 ft. to 4 ft. intervals along each side. With the shorter cribs a door at one end was sufficient for convenience of filling, but where the length approached or exceeded 20 ft. it was found desirable to have a door at each end. In some cases landing-stages were built for convenience in filling, but it was found desirable that these should be movable so that they could be dispensed with at shelling.

A modification of this type of crib has arisen through a desire to reduce expenditure. The sides in this case are vertical, being constructed of spalings spaced at 4 ft. intervals with longitudinal battens to support the wire netting which is used to line the crib. The roof is of the lean-to type. This is perhaps the least desirable of all types when storage is required for long periods, as losses due to birds, mice, &c., are considerable; but where shelling follows harvesting within a short storage period, or where maize-growing is not a regular practice on the farm, it provided the grower with a cheap means of storing the crop.

On the larger maize areas, where considerable space is required, it is often the practice to build two long cribs—up to 40 ft. each in length and parallel to one another—under the one gable roof, with sufficient space between them to provide accommodation for the various farm implements. Doors for filling are usually provided at each end, with sliding-doors situated midway down the inner sides of the cribs to provide means for feeding cobs to the sheller, which is usually brought into the implement space to allow of shelling from both cribs without having to move the machine. These cribs which have vertical walls, are usually 6 ft. wide, 8 ft. to 9 ft. high, and from 20 ft. to 40 ft. in length. In addition to housing implements the space between the cribs promotes air-currents, which materially assist in the drying of the grain. Arising out of the foregoing type there has also been evolved a single crib similar in all respects to each section of the double crib just described.

It is claimed for this type of crib that owing to the vertical walls there is far less strain on the walls than in the case of the type with tapering sides, and consequently there is no necessity to strengthen the sides with wall supports. Furthermore, greater capacity is claimed without increase in expenditure on timber. A somewhat greater overhang of the roof is necessary, however, to protect the cobs efficiently from the weather. Various other modifications are occasionally encountered, chief of which perhaps is the single crib built on to the back of an implement-shed; but the great majority conform to one or other of the foregoing types.

RECOMMENDED DESIGNS.

With the object of providing information on the construction and cost of cribs embodying the most desirable features, drawings, specifications and estimates were recently prepared by the Agriculture and Public Works Departments for the guidance of growers. Two designs were adopted. A combined double crib and implement-shed, for areas up to 18 acres where the crops average about 50 bushels per acre and a single crib embodying the features of one storage section of the double type, for areas of six to seven acres at a similar crop average.

In explanation of the dimensions given for the cribs it should be understood that heights and widths as specified have been arrived at as the most suitable for promoting best drying conditions. Growers with considerable experience regard 6 ft. to 7 ft. as the greatest width that should be employed in any crib. In regard to height there is a greater range of opinion; but even in this respect few successful growers favour heights exceeding 10 ft; generally 8 ft. is regarded as the most suitable. The length of crib can be varied between wide limits, and will depend to a great extent on the quantity of maize to be stored.

SITE AND POINTS IN CONSTRUCTION.

Realising that the chief point in storing maize cobs in a crib is to provide sufficient aeration to allow the grain to fully mature, it will be at once apparent that choice of site for the crib is of some importance. Air-currents play a greater part in efficiently drying out the grain than does warmth direct from the sun. Consequently, where it can be conveniently arranged, a site near or under a belt of tall trees would be preferred to one in the open, as direct sunlight on the grain bleaches it, thereby making it less attractive when marketed. On no account, however, should a crib be built where the soil is unduly damp, as the moisture in rising has a deteriorating effect on the grain.

It is desirable to have the floor at least $2\frac{1}{2}$ ft. from the ground, so as to allow air to freely circulate beneath as well as around the crib. Rising soil moisture can then escape without in some measure passing into the lower layers of cobs. The flooring itself will be more effective in promoting drying if the boards are spaced so as to allow $\frac{1}{2}$ in. to 1 in. spaces between them. There will be perhaps a slight loss of grain between the boards but this is comparatively insignificant compared with the benefit derived from the improved aeration of the lower portion of the crib.

Walls and ends should always be timbered vertically with 3 in. by 1 in. battens spaced 1 in. to $1\frac{1}{2}$ in. apart to allow of aeration. In addition it is desirable, although perhaps not essential, to have the crib lined with bird netting so as to reduce losses of grain. A gable roof is much more satisfactory than one of the lean-to type as it is easier to provide adequate overhang with this type for protecting the cobs from the weather.

Tin shields are occasionally employed on the blocks in an endeavour to keep out rats and mice, but, owing to the fact that most cribs are not more than 2 ft. to 3 ft. above ground-level, it is doubtful whether their general use could be advocated. Rats in particular would have little difficulty in jumping from ground-level, but fortunately they are not a serious pest in most cribs in the maize-growing areas.

MAIZE.

By H. R. SURRIDGE, A.R.C.Sc. (I.), Agronomist.

THE evidence of history is that maize originated from America. Since the discovery of that country in the fifteenth century, the cultivation of maize has extended throughout the world so that it now holds a leading place with wheat and rice as a staple food crop. The following figures extracted from the *International Year Book of Agricultural Statistics, 1928-1929*, show the important position that maize holds amongst the world's cereal crops:—

Wheat, 1,225,223,000 quintals; Maize, 1,079,119,000 quintals; Rice, 880,163,000; Oats, 731,625,000; Rye, 437,592,000; Barley, 403,964,000. (quintal=100lb).

In Fiji maize has been grown for many years. Seemann in his *Flora Vitiensis*, states that at the time of his visit (1865-1873), "only one kind of corn—a small yellow grained one—was cultivated by the white settlers, the native not having as yet, taken to growing it." Since Seemann's time, with the continued settlement of the country by Europeans and subsequently Indians, the cultivation of maize has extended so that in recent years there has usually been an exportable surplus, varying within wide limits, as shewn by the following figures extracted from the Fiji Blue Books:—

1920, 42,732 bushels; 1921, 62 bushels; 1922, 1,030 bushels; 1923, nil; 1924, 210 bushels; 1925, 2,048 bushels; 1926, 1,513 bushels; 1927, 2,560 bushels; 1928, $3\frac{1}{2}$ bushels; 1929, 4 bushels.

These fluctuations would appear to be due more to poor quality with the consequent low prices than to prevailing low prices for maize of standard quality.

As a food crop for human consumption it has not yet attained, in these islands, the place it deserves, its present uses being mainly confined to stock and poultry. The crop is a simple one to grow, the plant being adaptable to a wide range of conditions as regards climates and soils, demanding

of the grower a deep preparatory cultivation and subsequent clean land. As might be expected, the cultivation of this crop reaches its highest development in America where its importance as a crop exceeds that of wheat.

Species and Varieties.—The different species show variations in such points as time required for maturing, height of plant, size of leaves, position of the ear or cob on the stalk, the number of ears, the size and shape of the cob, the number of rows of seed, their regularity or otherwise, and the size, shape colour &c., of the grain. These variations are due primarily to the ease with which maize is cross fertilised, so that it is worth noting that the choice of a variety is of much less importance than the improvement of that variety when once chosen.

Selection of Seed.—The fundamental principle behind what is termed "Mendel's Law of inheritance" is that "like begets like." In selecting seed for planting, therefore, particular attention should be paid to the type of seed demanded by the market in which seed the will be sold. In New Zealand a smaller grain is preferred, since most of the maize required is for poultry.

The feeding value of the grain depends upon its construction. The white starchy part contains less protein, that is flesh forming material, than the horny starchy part and is therefore less valuable. The germ, though rich in proteins is chiefly valuable for the oil it contains, so that to secure a grain of high feeding value it is necessary to select the grain with the largest germ and the smallest starch content. Further, the process of selection must extend to the cob by selecting those cobs of the greatest uniformity, with seeds as already described, set in regular rows and tightly packed. The seeds at both ends of all cobs should be discarded since their progeny will not give the desired result. The nearer the cob is, in shape, to the perfect cylinder, the higher the possible yield.

In maize, colour appears to answer the purpose of identification only; no one colour appearing superior to another. There are three general colours, white, yellow, and red. White is always white and readily distinguishable. Yellow ranges from a pale lemon to orange presenting difficulty in identification only when approaching the border line between orange and red. The reds usually separate out into light reds with a white cap and dark reds without the white cap. In selecting corn, therefore, select cobs of uniform shape, size and colour, discarding all ears which appear diseased, discoloured, irregular in shape, and with rows not straight. The longest ears are required together with seed having the largest proportion of germ to starch.

To Produce good Seed.—For those who wish to improve their maize the following is probably the best method to secure the desired result in the shortest time. The method is known as the "ear to row" method, and consists of selecting the best cobs that conform to the required standard, discarding the seeds at the base and tip, using the remainder for sowing. A good cob should give from 400–600 seeds, so that the length of the planted rows will be controlled by the cob with the least number of seeds.

Mark out the rows and sow the seeds of one cob to one row, until all the cobs have been disposed of. The surplus grain, that is the grain over and above that required for the rows, can be mixed and sown in the usual way. It is necessary, however, to isolate these seed rows from the general crop, if possible, by growing another tall crop betwixt the two. The reason for this, as already given, is that maize is cross fertilised so easily.

On the seed crop maturing, the procedure of selection has again to be repeated. In the course of a few seasons it will be found that a very uniform crop can be grown giving a higher return per acre, which will more than compensate for the care and attention given to selection.

Soil.—To secure the best results with maize, good soil containing plenty of humus is required, a condition which obtains most on the alluvial flats and small areas of "bila" land found throughout these islands. A medium to heavy loam is preferable.

Preparation of Soil.—Maize requires deep cultivation, the success of the crop depending probably more on the preparation before sowing than perhaps any other factor. A good deep ploughing, followed by a thorough harrowing to work the land up to a fine tilth is required. Wherever possible, all humus, *i.e.*, dead leaves, stalks &c., should be ploughed in, to maintain the fertility of the soil and improve its physical condition and moisture content.

Planting.—This process can be done by hand or with the aid of a maize drill. The land should be marked out in rows, with the plough, and the seed dropped into the furrow, the furrow being 2 in. or 3 in. deep, at intervals. The distance apart in the rows depends on the method of cultivation following the planting. To drill a field in one direction means cultivating in one direction, therefore single seeds may be sown in the furrow or drill, one foot apart, with the drills four feet apart. If, however, the "check" system is adopted, the field is drilled or lined in two directions, up the field and across the field at right angles, three or four seeds being planted at the intersections of the lines. By this method, subsequent cultivation can be done in two directions by horse or other implements and the land receives a more thorough cleaning and stirring. The distance apart of the lines will depend on the quality of the soil, but 3 ft. to 4 ft. would serve in most places.

In New South Wales the use of a furrow opener in front of the maize drill has been found of service under certain conditions, especially where nut grass is troublesome. The furrow opener consists of a pair of discs set at an angle and close together in front, or a pair of double mould board sweeps which precede the drill and help to steady the drill in action. Amongst nut grass this method has been found essential.

Season of Planting.—In these islands, maize can be sown at almost any time. That sown, however, at the commencement of the rains would be harvested at the close of the wet season. Such corn will not keep too well and is therefore not good for export. That sown towards the end of the wet season, and harvested during the dry season, will keep better and be more suitable for export. The early sowings are usually attacked by weevils while the later sowings do not suffer so severely.

In considering the New Zealand market, to secure the best prices, maize must be marketed between April and June to catch the market before the South African shipment arrives. If forwarded for sale after June, it must be of the highest quality to compete with the overseas corn then arriving. Therefore, in growing for export, the planting season will be controlled by the final destination of the crop.

Fodder Requirements.—The foregoing directions refer to maize planting for corn production. Amongst the dairy men of these islands maize might be of service as a green fodder, during the dry season when grass nutriment is at its lowest. Maize when sown singly and fairly close together tends

to sucker freely so that a heavy green fodder crop would result from the sowing of single seeds in drills about 3 feet apart. Such maize, however, would not produce a very good quality corn.

Cultivation.—When the plants are one foot high, thin out the weaklings (check planting) leaving one strong plant to each planting hole. This will tend towards maximum yield.

During growth the soil should be worked towards the plants to enable the plant to secure a firm hold on the ground to withstand heavy rains and wind. Shallow cultivation only should be done and continued until the plants are sufficiently high enough to check all weed growth. Several light cultivations are of more benefit than two or three severe cultivations. The necessity is to keep down weeds, maintain a thin soil mulch to allow rain to enter the soil freely and conserve soil moisture.

In New South Wales harrowing is commenced immediately after sowing and continued until the plants are 6 in. or 8 in. high. It is claimed that plants treated this way stand up better against lodging by wind, while the harrowing destroys the weeds and maintains a thin soil mulch.

Manuring the Crop.—Although maize has been grown for a considerable time in these islands no suitable manuring formula has been evolved. Lands that are subject to flooding are usually renovated by that flooding, but where land has not this advantage every effort should be made to return as much as is taken out by the crop. With a crop that is sown for the grain, a heavy drain is made on the fertility of the soil producing that crop, so that every effort should be made to conserve fertility by returning all leaves, stalks, &c. Also experiments should be undertaken with artificial manures to secure the highest return for the money invested.

A useful rotation to work with land given up to maize is to sow Mauritius Bean either alternately or once in every two years. If grown alternately it should be possible to secure a profit from the sale of the bean seed. If, however, the bean is sown once in two years, it would be preferable to plough in the bean crop about flowering time. This would give humus and nitrogen to the soil and succeeding crop with beneficial results.

No system of crop rotation with reference to maize has been worked out for Fiji, but it should be practical to work maize in with a rotation of some leguminous crop, *e.g.*, Mauritius Bean, tobacco, cotton and perhaps potatoes in some districts, with beneficial results to the crops and therefore the producer.

Harvesting.—When the corn stalks have dried, the maize is ready for harvesting. Here in Fiji only the grain is of major importance, so that the cobs are gathered in from the field, husked and spread out to dry. This latter operation is most important for the value of the grain in most outside markets depends upon its dryness; for export it should not exceed 12 per cent. of moisture. To secure this degree of dryness, very thorough and efficient drying is essential and close attention should be given to the whole operation to secure the minimum moisture requirements of the final market. If the ears are broken from the stalk before the grain is thoroughly dry, considerable shrinkage takes place.

In America and South Africa use is made of the stalk, leaves, husks and shelled cobs for various kinds of stock feeding, the manure results from this feed being returned to the land for the following crop.

Crop.—In most countries 40–60 bushels per acre may be taken as a fair average crop although individual farmers in America and South Africa frequently exceed 100 bushels of shelled corn per acre. In Fiji no reliable

records are available, individual cases of 40 bushels per acre are known and considered very good. From these figures it will be seen that considerable improvement could be made in the growing of the crop here.

Shelling.—This is performed when the whole ear is quite dry and the grains are required for market separated from the cob. Several machines for shelling husked maize are on the market at prices ranging from £2 or £3 to nearly £100. In selecting one the chief point to take into consideration is the amount of corn to be shelled.

Storing.—Maize may be stored with the husk left on or after it has been husked. That with the husk left on suffers less from insect attack during storage. To keep well, maize *must* be thoroughly dry. Thorough drying of the grain hardens the outer seed coat and tends to reduce the risk of attack from weevils, moulds, &c., at the same time killing eggs and spores that would be present.

Marketing.—All maize should be carefully sorted before marketing, separating all inferior and immature grains particularly, those attacked by moulds or insects, so that the sample offered is sound, clean corn. For the export trade the sample should also be thoroughly dry, *i.e.*, the moisture content should not exceed 12 per cent.

DISEASES AND PESTS.

In Fiji the chief pests of the maize crop appear to be the maize moth and the maize weevil, both attacking the dry grain. Leaf hoppers and aphids are often present on the leaves and leaf stalks but, at present, do not appear to affect the plant or the yield.

The minah is very troublesome amongst young maize in certain localities, the birds rooting up the young seedlings and eating the seed that is still attached to the roots, or, where the seedlings are rather older, breaking the stem of the plant in their endeavours to uproot them. The moth and weevil already referred to, are pests which usually attack the stored grain and therefore concern the large grower and the merchant who has to effect storage pending the sale of the grain.

The maize moth.—These are small greenish-brown moths found in the neighbourhood of stored grain, usually in great numbers, resting during the daytime with the wings close to the sides of the body. In this position the fore-wing shows a dark band across the body about one-third of the way from the base. The hind-wings are pale brown in colour with no particular markings. The wings when expanded measure about three-fifths inches, while the length is about half that. The female moth lays its eggs *on* the husked grain, from which a small larvæ emerges in due course which bores into and destroys the grain, working from one grain to another until fully fed, when it pupates, emerging as an adult moth in 9 or 10 days to repeat the process. This causes considerable damage amongst the stored grain.

Control.—To prevent such damage, the corn should be stored after husking in clean, sound, closely-woven bags. Another method, where practical, is to fumigate the grain to destroy all moths with carbon bisulphide at the rate of 1 lb to every ton of grain or 1,000 cubic feet of bin space. When using this substance, great care must be exercised and all lights extinguished as the poisonous vapour is extremely inflammable.

The grain weevil (Calandra granaria).—This is a small brown weevil about one-eighth of an inch in length and, like all weevils, has the typical long snout with which it attacks the grain. Its life history is similar to that of the maize moth, except that in this case the grain is punctured and the egg

is laid *inside*. From this egg a small larva hatches out, feeds in the grain, leaving the outside skin. This is repeated until the larva is fully fed, when it passes through a resting stage to emerge eventually as an adult weevil. The adult weevil also attacks the grain so that the attack is constant and continuous.

Control.—Thorough drying of the grain and good clean, storage go far to reduce the damage caused by this pest. The heating of improperly dried grain during storage establishes favourable conditions for these insects. Fumigation with carbon bisulphide or hydrocyanic acid gas is also a satisfactory method of destroying weevils under certain storage conditions.

GINGER.

INQUIRIES have been received on the subject of the local cultivation of ginger. The matter was referred to the Director of the Imperial Institute, London, whose reply, together with a valuable article on the subject, is published below:—

N. 1173/5.

Imperial Institute, South Kensington,
London, S.W.7, 22nd April, 1930.

Sir,

With reference to your letter of the 5th March (No. 341/30) on the subject of ginger, I enclose herewith a cutting of an article on *Ginger—Its Cultivation, Preparation and Trade* from the *Bulletin of the Imperial Institute*, Vol. XXIV (1926), No. 4, which will probably supply much of the information that you require. With regard to possible markets for the product you will note from the section* of the article relative to trade and production (p. 678) that the bulk of the dried ginger produced in Jamaica, India and Sierra Leone is taken by Great Britain and the United States.

There is little to add to the information on methods of cultivation and preparation contained in this article. It may be pointed out, however, that the crop should be prepared in the form of the dried, peeled "root"; the production of preserved ginger such as is shipped from China requires special methods of cultivation and preparation. The market value of peeled ginger depends very largely on the method of preparation and the care with which the process of peeling is carried out. The best Jamaica ginger, for example, is at present realising 71s. to 90s. per cwt. as compared with 45s. per cwt. for the less well-prepared product from West Africa. Twelve months ago, the corresponding figures were 110s. to 120s. and 54s. per cwt. respectively.

Consignments of ginger or other spices could be sold in London through brokers, or possibly direct to merchants. The following firms are interested in spices:—

Brokers—

Messrs. Lewis & Peat Ltd., 6 Mincing Lane, E.C.3.

Messrs. Dalton & Young, 28 Fenchurch Street, E.C.3.

Messrs. Samuel Figgis & Co., 45 Fenchurch Street, E.C. 3.

Messrs. Hale & Son, 10 Fenchurch Street, E.C.4.

* Not published.

Merchants—

Messrs. Joseph Travers & Sons Ltd., 119 Cannon Street, E.C.4

Messrs. Dunlop Bros. & Co., 12 Fenchurch Avenue, E.C., 3.

Consignments should be forwarded through a shipping agent and it would be desirable in the first instance to communicate with the broker or other firm selected, in order that proper arrangements for shipping might be made.

I am &c.,

ERNEST GOULDING,
for the Director.

The bulk of the world's supplies of dried ginger is at present produced within the Empire, in the West Indies, India, and West Africa. Jamaica ginger is of a relatively uniform high grade. Indian ginger is on the whole of somewhat lower quality, although certain kinds, such as Calicut ginger, realise prices approaching those of Jamaica ginger. The ginger produced in Sierra Leone, however, which forms a very large proportion of the material imported into the United Kingdom, is of a lower grade. The Imperial Institute is informed that the United Kingdom market could absorb increased supplies of ginger of the better qualities, and for this reason it has been considered desirable to draw the attention of present and potential producers to the best methods of cultivating the plant and preparing the product for the market. In the case of Sierra Leone and Dominica this has already been done to some extent by means of a memorandum sent recently by the Imperial Institute to the respective Governments of those countries. Through the agency of the present article, it is hoped to create an interest in the product in other parts of the Empire, where the conditions are suitable for its production.

THE GINGER PLANT.

The ginger of commerce consists of the underground stem or rhizome of a herbaceous perennial, *Zingiber officinale*, Roscoe, belonging to the natural order Zingiberaceæ, a section of the Scitamineæ. The rhizome is branched and bears at intervals upright leafy shoots, about 2 ft. high, and, usually distinct from these, an erect flowering shoot.

From very early times the plant has been grown from cuttings of the rhizome and, like certain other plants which are propagated entirely by vegetative means, such as the banana, fertile seed is rarely produced. The cultivated plant consequently shows little variation in botanical characters and the various forms of ginger which appear on the market owe their differences almost entirely to the method of cultivation and preparation practised in the region of production. It was at one time stated that the relatively juicy Canton ginger, from which the Chinese preserved ginger is prepared, was derived from a distinct though related plant, *Alpinia galanga*. This, however, is now known to be erroneous, and the succulence and slight pungency characteristic of Chinese ginger appear to be due to the special methods of cultivation adopted in China and to the rhizome being harvested at a comparatively early age (see p. 12).

The original home of the ginger plant is not known with certainty. It occurs wild in South-east Asia and in the Malay Archipelago, and it has also been recorded in a wild state in Columbia. It has been suggested, however, that the plants found in Colombia are relics of early cultivation, as may possibly be the case also in the other two regions mentioned.

CULTIVATION AND PREPARATION.

Climatic Requirements.

For the successful cultivation of ginger the essential requirements as regards climate are a good rainfall and a high temperature during the growing period. In the ginger-growing region of Jamaica the mean annual rainfall is 89 in., whilst in south-west India it is over 100 in. A dry season during the resting period and prior to planting is an advantage, as it facilitates the thorough preparation of the soil required for the crop, but is not essential.

Owing to the fact that a high temperature is needed for the optimum growth of the plant, cultivation is naturally most successful in tropical and sub-tropical regions. It need not be restricted to such areas however. Provided that the heat and sunshine are sufficient during the greater part of the year, a cold winter is immaterial, as before this period is reached the rhizomes will have been dug up from the ground, the bulk already prepared for the market and the remainder stored for planting the following season. These are actually the conditions obtaining round Canton and also in parts of Queensland where the crop is grown.

As regards altitude the plant succeeds in Jamaica from sea-level to considerable elevations, and in India also it is grown both in the low country and up to 4,000-5,000 ft. in the Himalayas.

Soil and Manure.

Ginger is an exhaustive crop and, unless manures are readily and cheaply available, the soil in which it is grown must be rich in plant food. The plant will not succeed in land liable to become water-logged or in soil of a gravelly or very sandy nature. The most suitable kind of soil, therefore, is a rich vegetable loam. The land must be well drained, as if water collects about the rhizome the latter is liable to rot.

The best varieties of Jamaica ginger are grown on a sandy loam, and in India the ginger produced on the compact black soils is said to be inferior to that grown on the lighter sandy loams. The amount of sand should probably be not more than 30 per cent., and of clay not above 20 per cent.

In Jamaica the primitive plan of clearing forest lands by fire was largely followed, and on this cleared land ginger was grown until the soil became exhausted, when it was abandoned and a new piece of land put into cultivation. This wasteful method resulted in the production of large tracts of exhausted land, which could only be brought under cultivation once more after considerable expenditure on chemical manures. In order to avoid this objectionable way of using land, experiments were carried out by the Jamaica Agricultural Society with a view to ascertaining the most suitable manures for ginger. A mixture composed of marl, with 10 per cent. each of soluble phosphates, ammonia, and potash salts, applied at the rate of one ton per acre, gave the best results. On worn-out land a yield equivalent to 2,960 lb of ginger per acre was obtained with this manure, whilst on the unmanured, exhausted land the plants hardly grew, and gave no return.

In most parts of India manuring is regularly practised, the manures generally employed being oil-cake and dung. In some parts old and well-decayed cow-dung is either applied at the time of the first ploughing or is put in the holes made when planting the crop. During growth the ground is sometimes top-dressed with mustard-cake and castor-cake, whilst the mulch of leaves, &c., often applied to the ground after planting, also serves to enrich the soil.

The principal constituents removed from the soil by ginger are stated to be lime and phosphoric acid, and it is the replacement of these constituents which should be aimed at.

Cultivation.

In Jamaica two methods of cultivation are adopted. That by which the best ginger is obtained consists in planting in March or April portions of selected rhizomes from the previous year's crop, care being taken that each portion planted contains an "eye" (embryo stem). The land is raised into ridges and the pieces of rhizome are placed a few inches below the surface and about one foot apart, the process being much the same as that observed in planting potatoes. It is advisable thoroughly to clear the land of weeds before planting the rhizomes, as the removal of weeds become difficult later on when the ginger plants have developed. Unless the rainfall is good it is necessary to resort to irrigation, as the plants require a good supply of water. The ginger produced in the foregoing way is known as "plant ginger."

"Ratoon ginger" is obtained by leaving in the soil from year to year a portion of a rhizome containing an "eye." This "eye" develops in the normal way, giving rise to a supply of rhizomes in the succeeding season. "Ratoon ginger" is smaller and contains more fibre than "plant ginger," and the product obtained by this means is said to deteriorate steadily from year to year.

In some parts of India it is usual to plant the crop in beds about 10 to 12 ft. long and 3 or 4 ft. wide, in which the sets are placed about 9 in. to 1 ft. apart. The field is then covered over with the leaves of trees or other green manure to keep the soil moist, and over the leaves organic manure is spread to a depth of about $\frac{1}{2}$ in. At the end of the rainy season it is necessary to resort to irrigation. During the first three months of the dry season the field is weeded about three times.

Before planting, the land must be thoroughly hoed (or ploughed) and harrowed, in order to produce a fine tilth. In planting large fields it would appear preferable to open up drills about 4 in. deep and 2 ft. apart, much as is done in planting potatoes on a large scale. Artificial manure, such as superphosphate and bone meal, can then be incorporated in the soil at the bottom of the drill, before planting the sets.

On account of the crop taking up such large quantities of plant food a system of rotation should be adopted if possible. This is done in some parts of Jamaica, where much of the ginger is grown in small quantities as a garden plant, in association with bananas, chillies, &c.

The method of growing ginger in the Canton district of China differs considerably from that practised in countries where dried ginger is the objective. Low-lying ground is usually selected for the crop and the cuttings are set at intervals of 6 in. in ridges about 1 ft. high and 2 ft. apart. Water is kept continuously between the ridges. After the shoots have reached a height of from 6 in. to 1 ft. the plants are heavily manured at frequent intervals with urine or nightsoil mixed with water. This favours the formation of the succulent rhizome characteristic of Chinese ginger.

"Ratoon ginger" matures early, and in Jamaica is harvested from March to December; but "plant ginger" is not ready for digging until December or January, the rhizomes being gathered as they mature from that time until March. The rhizomes are known to be ready for digging when the stalks wither, this taking place shortly after the disappearance of the flowers. In Jamaica the plant flowers during September. The rhizomes are twisted

out of the ground with a fork or a hoe. In performing this operation great care is necessary, as any injury inflicted on the rhizome depreciates its market value. Considerable experience is necessary in order to lift ginger rhizomes properly.

The "hands" (complete rhizomes and adherent fibrous roots) are piled in heaps, the fibrous roots are broken off, and the soil and dirt removed immediately, as otherwise it is difficult to get the finished ginger white. The rhizomes should not be allowed to lie long in heaps, as they are liable to ferment. The usual plan is, as soon as the rootlets and excess of soil have been removed, to throw the ginger into water to be ready for "peeling" or "scraping." This is done in Jamaica by means of a special knife, consisting merely of a narrow straight blade riveted to a wooden handle; in India the outer skin is scraped off with a shell or piece of broken earthenware. In the case of Sierra Leone ginger of the ordinary grade the flat sides of the hands are scraped with a spoon and the hands are then laid out to dry without washing in water.

The operation of peeling, if carried out in a proper manner, is a very delicate one, the object being to remove the skin without destroying the cells immediately below it, since these cells contain much of the oil upon which the aroma of the best qualities of ginger depends. As the rhizomes are peeled they are thrown into water and washed; and the more carefully the washing is done the whiter will be the resulting product. As a rule the peeled "hands" are allowed to remain in water overnight. Some planters in Jamaica add a small proportion of limejuice to the wash water at this stage, at the rate of about half a pint to six or seven gallons of water, in order to produce a whiter root.

After washing, the peeled rhizomes are placed in a "barbecue," which consists merely of a piece of levelled ground covered with cement, on which the ginger is placed to dry in the sun. Where a "barbecue" is not available, a "mat," consisting of sticks driven into the ground, across which are laid boards or palm or banana leaves, is used, on which the ginger is exposed until it is dry. Uniform drying of the rhizomes is essential for the production of first-class ginger and to prevent mildew; and to ensure this they should be separately turned over by hand at least once on the first day. Careful planters put their ginger out daily at sunrise, and take it in each night at sundown; conducted in the latter way the operation of drying usually takes from six to eight days. The ginger, if not sufficiently white in appearance, has to be bleached by further washing, and after being re-dried is ready to be packed for export. In some parts of India the peeled rhizomes are bleached by soaking in lime-water for a short time and exposing them for about 12 hours after drying to the fumes of burning sulphur in a specially constructed bleaching-room, at the rate of 7 lb of sulphur per ton of rhizomes.

The finished ginger is graded according to size and colour of the "hands"—the best grades consisting of the large plump "hands" free from traces of mildew, and the poorest shrivelled, dark-coloured "hands." As a rule the crop is divided into four or five grades. The best "hands" obtained in Jamaica weigh as much as 8 oz., 4 oz. being an average weight.

Unpeeled ginger is merely freed from its rootlets and excess of soil, and then thoroughly washed in water or scalded in a boiler of hot water, and finally dried in the sun.

Preparation of Preserved Ginger.—In China the first crop of ginger is ready about three months after planting. This is known as "young ginger" and is the least pungent and most expensive. Unlike the Jamaica and

Indian ginger, the rhizomes are not allowed to mature, as they become too pungent for the purpose for which they are required. After harvesting the roots are washed and the skin carefully scrapped off. They are then punctured by means of a fork and afterwards washed in rice water (the water left after washing rice) to improve the colour. The rhizomes are next boiled in three or four changes of refined sugar and water for one or two hours, until thoroughly soaked. They are then placed in barrels or other containers and covered with syrup. In the case of dry preserved ginger, the wet rhizomes are strained till dry and then rolled in sugar placed on bamboo matting.

Yield.

The yield of ginger varies considerably with the climate, soil, and methods of cultivation employed. In Jamaica the average return is from 1,000 to 1,500 lb of dried ginger per acre, but as much as 2,000 lb per acre has been obtained under the best conditions. The recorded yields in different parts of India vary within wide limits. In Bengal it is stated that 1,000 to 1,500 lb per acre is the average crop, in the Punjab 2,100 lb, in Travancore 2,000 to 2,500 lb, whilst in an experimental cultivation at Surat, Bombay Presidency, the yield was equivalent to over 8,000 lb per acre. As already mentioned, a yield equivalent to nearly 3,000 lb per acre was obtained in Jamaica on exhausted land by the application of a suitable manure; and there is no doubt that, by careful cultivation and manuring, the yield in all the countries mentioned could be considerably increased. It takes about 4 tons of fresh dug rhizomes to give 1 ton of dried ginger.

Pests and Diseases.

Owing to the pungent nature of the shoots, the ginger plant is attacked by very few insect pests, and it has even been recommended that the crop should be planted in orchards to prevent the development of pests of fruit trees. At the Rangpur Agricultural Station, Bengal, however, the larva of a Drosophilid fly, which lives on coarse grasses, has been observed to do a good deal of harm to the shoots.

In Southern India the caterpillar of a butterfly, *Udaspes folus*, sometimes does great damage to the leaves, whilst the caterpillar of a moth, *Dicthocrocis punctiferalis*, bores into the stem and rhizome, but seldom does serious harm. The latter is better known as a pest of castor plant in Southern India. In Travancore the rhizome is bored by the larva of a small fly (*calabota* sp.) which deposits its eggs at the base of the plants; when the crop is gathered the larva migrates to wild arrowroot, where it completes its development. The best remedy is stated to be the destruction of the alternative food plant.

The coconut scale, *Aspidiotus destructor*, has been found to occur on ginger in Fiji, but no information appears to be on record as to the extent of the damage caused.

Considerable injury is inflicted on ginger crops in Jamaica by a disease called "black rot," which attacks the underground parts of the plant, and brings about decay of the rhizomes. The first indication of the disease is a yellowing of the leaves, which droop and wither; the bases of the stems become discoloured and rot, and finally decay spreads to the rhizomes, which disintegrate to form a putrefying mass of tissue. A fungus present in the decomposing rhizomes was found to form spores in a similar manner to *Allantospora radiculicola*, Wakker, a fungus which causes a root disease of sugar-cane in Java. It was not clearly shown, however, that the fungus found in the old rhizome was the cause of the disease (Howard, *Bull. Bot. Dept., Jamaica*, 1901, 8. 181; 1902, 9, 42).

A similar rot of the rhizome, caused by a species of *Pythium*, which occurs in India, was first recorded by Butler from Surat and is described by McRae in *Agri. Journ., India* (1911, 6, 139). The disease spreads rapidly through the soil, and to prevent infection of healthy plants every portion of an affected plant must be removed and burnt, whilst the soil itself should be treated with lime, or a light dressing of sulphate of iron may be applied. Isolation of infested soil by a trench has been tried with success, but in the case of a bad attack ginger should not be grown on the land for at least three years. The disease is most serious on wet, heavy soils or in exceptionally rainy seasons, and it may be prevented to a large extent by draining the land, so that no water lies round the collar of the plant. Great care should be exercised in selecting only healthy rhizomes for planting purposes, any plants with even the slightest trace of disease being rejected. After a bad attack it is advisable to steep the rhizomes for about half an hour in Bordeaux mixture before planting, to destroy any fungus spores or hyphæ on their surface or in the soil clinging to them. The fungus, which also occurs on tobacco and papaya in India, was at first thought to be *Pythium gracile*, Schenk, which in Europe is found on freshwater algæ. Subramaniam, however, showed that it is a distinct species, which he calls *Pythium Butleri* (*Mem. Dept. Agri., India, Bot. Ser.*, 1919, 10, 181).

Another disease of ginger which does some damage in Jamaica is locally called "cork rot." This cannot be detected until the crop is gathered, when the rhizomes are found to be of cork-like texture and quite valueless. The exact nature of this disease does not appear to have been investigated.

A new disease of ginger, caused by *Vermicularia Zingiberæ* and reported from the Godaveri District, is described by Sundararaman in *Mem. Agri. Journ., India, Bot. Ser.* (1922, 11, 209). The disease begins with small yellowish spots and later the whole leaf turns yellow and rots, resulting in a poor development of the rhizome. It makes rapid progress during a period of continued wet weather and high humidity, but the advent of drier conditions checks its growth and the plant may recover. Spraying with Bordeaux mixture was found to be effective against the disease.

USES OF GINGER.

For flavouring purposes ginger is perhaps the most widely used of all spices. It is employed whole in the preparation of various confections, chutneys, pickles and the like, and in the ground condition for a great variety of purposes. Large quantities are used in the manufacture of ginger beer, ginger ale and similar beverages. Its medicinal value is well known, the root being used chiefly as a stomachic and internal stimulant, especially in flatulency and colic. The pungency of ginger is due to the presence of a resinous substance and the odour to an essential oil. The latter is separated by steam distillation and used to some extent in perfumery. The characters of the oil are dealt with in this *Bulletin* (pp. 651, 654) in connection with reports on a sample of ginger peelings from Sierra Leone and on a sample of the oil received from Seychelles.

In connection with the attempts being made to improve the quality of Sierra Leone ginger, the Imperial Institute recently made inquiries regarding the uses of the various types of ginger, the results of which may be here summarised.

Unscrapped (unpeeled) ginger is used as a cheap substitute for peeled ginger for most of the purposes for which the latter is usually employed. When peeled ginger is relatively cheap less unscrapped ginger is used in this way whilst, on the other hand, more of it is used when peeled ginger con-

mands a high price. A certain amount of unscraped ginger is also employed by distillers in the United Kingdom, who prefer it to peeled or scraped ginger, because it contains rather more essential oil. In the latter connection it was considered that the peelings might also find a market amongst distillers, and a sample was obtained from Sierra Leone for investigation at the Imperial Institute, the results of which are given on page 650 of this *Bulletin*.

For certain purposes only peeled ginger is suitable, *e.g.* for the "whole ginger" sold by grocers, for the best grades of ground ginger and for the best kinds of ginger beer. Unscraped ginger is sometimes used for the lower qualities of ground ginger, but not commonly for ginger beer. For medicinal use, "scraped" ginger alone is official in the British Pharmacopœia, but both peeled and unpeeled may be used for official preparations in the United States.

Ginger from no one country is in demand exclusively for any particular purpose. The peeled ginger from Jamaica, Cochin and Japan is all used for the same purposes, the grade of ginger employed depending on the quality of the article to be produced. Unscraped varieties from different sources are generally interchangeable.

From *Bulletin of the Imperial Institute*, 1926.

CULTIVATION OF PINEAPPLES.*

By D. H. GRIST, Agricultural Economist.

HAWAII and Malaya are the world's main centres for the production and canning of pineapples. The estimated area in bearing in Hawaii is 50,000 acres; while Malaya has a total of about 50,000 acres, 42,000 acres of which are situated in the State of Johore, and 8,000 acres on Singapore Island. Pineapple canning is also carried on to a lesser extent in South Africa (centred at Port Elizabeth), in Formosa and in parts of Australia.

The following account is a comparison of the systems of cultivation and the conditions obtaining in Malaya, Hawaii and South Africa.

Climate.

The climatic conditions in these three countries of production vary considerably. The following table shows the average rainfall and temperature.

Country.	Average rainfall. inches.	Average mean shade temperature.
Malaya (Johore)	89.09	80.0 F.
Hawaii (Honolulu)	31.60	74.6
South Africa (Port Elizabeth)	22.51	63.6

In Hawaii, the precipitation is heavier from November to March inclusive, but in South Africa the rainfall is fairly evenly distributed throughout the year. The rainfall in Johore is somewhat erratic; the rainy months are generally December to March, but there is usually an ample rainfall each month.

* The following account is compiled from information obtained over a number of years by officers of the Department of Agriculture S.S. & F.M.S. regarding Malayan pineapple cultivation; *Notes on the Pineapple Industry in Hawaii* supplied to the Director of Agriculture from a private source; and *The Pineapple Industry in South Africa* from a report by Mr. C. A. O'Conner of the Mauritius Department of Agriculture. Reference has been made to *Notes in Pineapple Cultivation* appearing in *The Tropical Agriculturist*, Vol. LXX, No. 1, January, 1928, and to *Growing and Canning Pineapple in the Hawaiian Islands*, in *Dun's International Review*, April, 1928.

The above figures demonstrate that pineapples will flourish within wide ranges of climate in the tropics or sub-tropics, but the system of cultivation must vary between these countries to adapt the crop to local climatic conditions.

SOILS.

Pineapples will grow on a wide range of soils, but favour the heavier types of soil with good soil aeration and drainage. The soils of Hawaii are of volcanic origin and rich in mineral plant foods. In Malaya, the crop thrives best on the stiff clay types of soil. A rich soil is held to be unsuitable as it tends to develop the size of fruit at the expense of flavour. It is for this reason that the fruit produced on the poorest of the Singapore lands have the best flavour when canned. It is probable that with a rich soil, growth is more rapid in Malaya than in either Hawaii or South Africa with their lower rainfall and temperature.

VARIETIES.

The two main varieties used in canning are the "Smooth Cayenne," a large pineapple with small "eyes," weighing about 5 to 6 lb and the "Queen" type, a smaller pineapple, with deeper and rather irregular eyes weighing about 3 to 5 lb. Opinions differ regarding the relative merits of these two varieties for canning purposes. It is held in Hawaii and South Africa—which have adopted the "Smooth Cayenne"—that the flavour of that variety is superior to that of the "Queen" types. In Malaya, the latter variety is used exclusively for canning as it is held to have a better flavour and to be more suitable for canning. Here again, it is possible that climatic and soil condition may be responsible for these differences of opinion, which, of course, are based on the experiences of the canners. The "Queen" type has two advantages of some importance—it is hardier, and it produces a greater number of "suckers" than does the "Smooth Cayenne," a matter of some importance in replacing or extending areas under the crop.

PRELIMINARY CULTIVATION.

The fundamental differences in system of cultivation between these three countries is that whereas in Hawaii and South Africa pineapples are treated as a sole crop, in Malaya they are almost invariably planted as a catch crop; generally in conjunction with Para rubber as the permanent crop.

In each case, it is realised that pineapples cannot be grown indefinitely on the same land: the land must either be rested after a number of years or it must be utilised for alternative crops after carrying pineapples for some years. The Hawaiian rich soils vary considerably; in some cases they produce fruit for three or four years, after which resting for one or more years is necessary; in other instances they are still bearing well after fifteen years. It is reported that many of the soils, however, are finished for pines after eight years. In Malaya, virgin soil is generally used for pineapple cultivation. The pineapples are planted directly the heavy jungle is felled, burnt and cleared. The plants commence to fruit in from 12 to 18 months, and will continue to fruit until the fifth to sixth year, by which time the fruits produced are small. The rubber which forms the main crop has also become a tree of considerable size, so that further cultivation of pineapples is out of the question.

Much of the Hawaiian pineapple land was formerly pasture land, but newer areas, in many cases, had to be cleared of cactus and rocks. It was never jungle and the islands are not thickly wooded. Abandoned land reverts to pasturage.

The South Africa pineapple land has to be cleared of bushes and grass.

Both in South Africa and Hawaii, the preliminary cleaning of the land is followed by a thorough cultivation of the soil. In the latter country, 95 per cent. of the land is cultivated with caterpillar tractors, steam ploughing equipment never being employed. As mentioned previously, in Malaya the land receives no cultivation before planting the pineapple plants.

PLANTING.

Pineapple planting material is of four descriptions: viz., ratoons, which are formed from buds on the stem among the roots; "suckers," formed in the leaf axils; slips, formed from buds appearing immediately below the fruit; and crown slips and crowns, formed from buds beneath and around the crown of the fruit. Ratoons and suckers are the most suitable for planting purposes, as they produce fruit earlier than do the less strongly developed slips, which are very small and should first be planted in a nursery to develop a strong root system. The effect of planting material and climate may be seen from the following comparison of the length of time taken for the plants to reach the bearing stages:—

Country.	Crowns.	Suckers.
Malaya	18 months	12 months
Hawaii	20 months	14—16 months
South Africa	2 to 2½ years.	

Considerable variation exists with planting distances employed in different countries. The usual Malayan system is to space the plants 5 ft. by 2½ ft., with a six foot path at every 100 feet. This spacing gives from 3,000 to 3,400 plants per acre. In Hawaii, it is customary to plant very close, 9,000 to 12,000 plants per acre, with a tendency towards an even denser population of plants. Slips or suckers are usually planted in double rows, 12 to 18 inches between plants in the row, 16 to 24 inches between rows. The distance between the centre of this double row and the centre of the next double row is about 6½ feet.

The South African practice is to plant in double rows, the plants being two feet in the row and two feet apart between rows; a space of five feet is left between the double rows. In this system there result about 6,300 plants per acre.

Suckers and ratoons for planting are cut square at the base, the lower leaves removed and frequently dried in the sun for a while before being planted. In some quarters it is held that there is no advantage in the preliminary drying, but it appears to be the usual practice both in Malaya and Hawaii.

The plants should be placed from three to four inches deep in the ground—the actual depth depending upon the size of the plant. Care must be taken that no soil or sand enters the bud as it will kill the plant, or at least retard its development.

CULTIVATION.

After planting, the fields require weeding, but apart from such attention no further cultivation is given in Malaya. In the other countries of production, however, the low rainfall renders it necessary to do everything possible to conserve the moisture in the soil. The usual method of frequent surface cultivation achieves this object, but in Hawaii, exceptional measures are taken, partly at least towards this end. The fields are mulched, with an asphalt-treated paper so spread as to provide spaces necessary for cultivation and harvesting. It is claimed that this mulch (under the commercial name of "Pabco") reduces weeding costs, conserves heat and moisture;

and so increase yields as to render it a financial success. The "Pabco" is first spread—sometimes by a machine which lays it flat, turns down the edges and kicks up earth to keep it down—and the plants placed in holes made in it with a trowel. The disadvantage mentioned against the "Pabco" mulch is that it forms a breeding ground for pests. This mulch is widely used in Hawaii. Owing to the heavy rainfall, it would not have the same advantages in Malaya. Pineapple land is ploughed four or five times a year on African plantations, the ploughing being done with oxen.

Mention must here be made of a peculiar feature in pineapple planting in Malaya. The great majority of the areas under this crop are owned by Chinese, who, in many cases, are the owners of the factories. The Chinese owner of land which he wishes developed with pineapples and rubber makes an arrangement with a number of Chinese squatters to plant up his land with pineapples and to keep it clean for an agreed charge per month per acre. Each squatter is thus definitely and absolutely responsible for a portion of the estate, and generally erects his own temporary abode thereon. The agreement provides that a squatter shall get 50 per cent. of the value of the pineapples as a bonus, after cartage costs have been deducted and the agreement usually contains a clause which provides for the payment to the squatter of a certain sum per acre for cleaning the pines off the land after five years. In one typical instance, the agreement provided for the payment to the squatter of \$1 an acre a month to cover the full cost of planting and weeding, a bonus of 50 per cent. of the value of pineapples after deduction of cartage costs, and the payment by the owner of \$8 per acre for cleaning off land and burning the pineapple plants at the completion of the agreement.

Such complicated methods of management are possible between Chinese and Chinese, but are impossible between European and Chinese.

The usual Malayan contract rates are around \$7 per acre for planting; and for weeding and earthing up plants, \$2.50 per acre per mensem.

In Hawaii, the land is manured just before planting, and a further application is sometimes given before the plants commence to bear fruit.

It is difficult to obtain data of the labour requirements for cultivation, but some idea of the probable cost can be obtained from the requirements of an Hawaiian plantation. An estate of three or four thousand acres is run by one man. Under him are Japanese conductors, one for every 1,000 acres. They will have under them ten heads of coolie gangs, each of which would be in charge of about ten coolies at the height of the season. Salaries: Manager, about \$1,000 per month; Divisional Manager, \$550; Conductor, \$90; all sharing in profits.

The permanent labour force is about 60 men per 1,000 acres, a number which is in excess of requirements in the slack season. This number may be increased to over 100 men per 1,000 acres during the busy season. Formerly, the labour force was mainly Japanese, but owing to restriction on Japanese immigration, they have now been largely replaced by Filipinos.

YIELDS.

In Malaya, there are two main crops per annum, the first in May and June and the second in November and December, but the plantations are producing fruit throughout the year. During the first year of fruiting the plant will produce one fruit, but in subsequent years, two fruits per plant are usually obtained. The average annual yield is between 4,000 and 5,000 fruits per acre per annum.

Although there is fruit being obtained throughout the year, the main Hawaiian harvest, June to August produces the heaviest crops, with a second

crop in December to February. When the first crop is obtained—one fruit per plant—all suckers, with the exception of two, are removed; as a rule, no further removal of ratoon are made unless they are required for planting purposes. The Hawaiian plantations, by reason of close planting, the application of manures and cultivation, produce heavier crops than are obtained in Malaya. In South Africa, the annual crop is estimated at between 6,000 and 10,000 fruits. Although the yields of pineapples from Malaya are small, it must be remembered that the capital invested is also smaller than with other countries, and that the land is planted with a second crop—rubber.

An estimate of the cost of bringing an acre of pineapples into bearing in Hawaii has been stated as follows (currency, dollars gold).

Clearing, \$40; ploughing, \$25; plants, \$56; planting, \$10; weeding and ploughing, \$27; fertilising, \$35; harvesting, \$13.50; collecting, \$36; total, \$242.50.

It must be understood that subsequent crops will cost very much less; the only fair way of arriving at cost being to average it over a period of not less than four years.

In a subsequent number of *The Malayan Agricultural Journal* it is proposed to conclude this series of articles on pineapples by a consideration of the subject of pineapple canning.

PIGS AND PIG PRODUCTS.

TWELFTH REPORT OF IMPERIAL ECONOMIC COMMITTEE.

RECENTLY published by the Imperial Economic Committee is a very interesting and valuable report entitled *Pigs and Pig Products*. The report deals with the marketing and preparation for market of pigs and pig products within the Empire and in those countries from which pig products are imported into Great Britain.

2. Much of the report, particularly that dealing with manufactured products and markets overseas, is of no economic interest to pig raisers in Fiji in the present state of our development and will not be considered in this review which will be confined to those parts dealing with such features of the industry as breeds and types, feeding, housing, association with dairying, grading, &c.

3. The following is a brief resumé of the points raised in which Fiji may be interested:—

Breeds.—White breeds are not popular in most tropical countries. These breeds are, however, very popular amongst the importing countries. Other popular breeds in the Empire are Berkshire, Tamworth, Gloucester Old Spot and others. The report, however, is unfavourable to a multiplicity of breeds, as such a condition is not conducive to the production of a uniform type so desired by the manufacturers and pork butchers.

Feeding.—The report emphasises the importance of an abundance of cheap food in pig raising areas. The areas raising the greatest proportion of pigs are those in which the chief products are maize, potatoes and dairy products. In U.S.A. five states, forming the centre of the maize belt produce two-fifths of the total number of pigs in that country. Other important foods are barley and other hard grains. The type of pig produced varies with the

food materials. Those fed chiefly upon potatoes or maize are of the very fat type, whilst those whose ration consists of milk products and hard grain are of the lean, very firm type.

Housing.—This question is not dealt with at much length by the report, but nevertheless is a subject of great importance. Housing requirements will vary depending on the climatic conditions.

Association of pig-breeding industry with dairying.—The necessity of establishing the pig-raising industry in connection with dairying is emphatically stressed. It is pointed out that the raising of pigs on the by-products of dairying is the most profitable method of disposing of such products. Denmark's example in this respect is pointed out, and attention is drawn to the suitability of New Zealand for pig-raising on account of its extensive dairying industry.

Marketing.—The keystone of this discussion is the necessity of co-operation among all persons interested in the pig-raising industry. First and foremost the consumers' needs must be satisfied, and to accomplish this, understanding must exist between breeders, agents, butchers and other people concerned in the trade. Each breeder should endeavour to maintain a regular supply, and organisation should exist amongst breeders to prevent over-production and to ensure a regular supply.

Pig-raising on closer settlement areas.—The report raises the point that pig-keeping plays or should play an important part in closer settlement. In Denmark one-third of the pigs are raised on farms of less than 37 acres and seven-eighths on farms of less than 150 acres.

THE PIG AND PIG PRODUCTS REPORT AS IT APPLIES TO FIJI.

By H. M. STUCHBERY, B.V.Sc.

Elsewhere in this *Journal* will be found a review of the report on pigs and pig products by the Imperial Economic Committee. This report contains much that is of interest to those associated with the industry in Fiji, and much valuable information may be gleaned from its pages.

2. The question of breeds is interesting. It will be noted that the white breeds are not popular in other tropical countries, but it cannot be said that these breeds do not thrive in Fiji provided they receive reasonable treatment. Certainly those kept in sties or having access to suitable shelter do quite well. Possibly, were they allowed to run at large without shelter from the tropical sun's rays they would not do as well as the other breeds, but this state of affairs is not usual in Fiji where abundance of shade is usually to be found. The coloured breeds such as the Berkshire and Tamworth do very well in Fiji.

3. Of the food sources mentioned in the report, the only ones common to Fiji are maize and dairy by-products. We have however, many foods here eminently suitable, such as rice-bran, coconut meal, bananas and various roots such as kumalas. Most of these could be produced very cheaply, much more so in fact than food-products used in other countries for pig-raising.

4. The question of pig-raising in association with dairying is an important one to Fiji. At present we are not making sufficient use of dairy by-products such as skim milk. By the feeding of these to pigs a much bigger revenue could be derived from dairy farms at little extra cost. In addition

to this, other good pig-foods could be obtained quite close to our dairying areas at a very reasonable cost. When the Tailevu road is completed all the dairying centres will be within easy reach of the main Suva market.

5. Suitable housing for pigs is most important in Fiji. The presence of parasites, particularly the kidney worm (*Stephanurus dentatus*), has to be considered, and methods of control adopted. Dirty and badly drained sties make ideal conditions for the spread of these parasites. On the other hand, these parasites spread with equal facility in damp low-lying, pastures or those with "wallow-holes" on them. Pig-sties should, therefore, be well drained, and capable of being cleaned and disinfected easily. As well as this, pastures should be dry and also be changed frequently.

6. Methods of marketing in Fiji, where there is only a local market to be supplied, will necessarily differ from those in other countries catering for both home and export markets. However, the principles of co-operation and understanding between each section concerned in the trade is just as important as is also the regular supply of pigs of a uniform type. At the present time, for the Suva market, the demand for pigs for slaughter is limited to about 80 animals a month. It would be necessary for breeders to keep their monthly supplies at this figure in order that there should be no over-production. There is, however, throughout the Colony, a considerable consumption of pig meat, whilst in the vicinity of Suva, a considerable amount is consumed by Chinese, Fijians and others, which is not included in these figures.

7. Profitable pig-raising appears to go hand in hand with closer settlement in agricultural and dairying communities. It is a fairly regular practice in other parts of the Empire, for the majority of farmers on closer settlement areas to indulge in pig-breeding to a greater or less extent. In Fiji we have many such areas eminently suitable for pig-breeding. The chief drawbacks at present are a lack of market for the animals if the industry was developed extensively, and the lack of knowledge on the part of settlers, of the principles of pig-breeding. It is probable, however, that the demand for pork and bacon will increase as time goes on and supplies will have to be increased.

8. There is an art in pig-raising and some skill is required. All farmers will not be successful but there would appear to be no reason why the industry should not be immediately developed by those adapted for it to meet at least our local requirements.

THE SECOND IMPERIAL MYCOLOGICAL CONFERENCE.

Report by J. G. C. CAMPBELL, B.Sc., Government Mycologist.

I HAVE the honour to submit the following report on my attendance, as representative of Fiji, at the Second Imperial Mycological Conference, held in London 23rd to 28th September, 1929.

2. On 16th September I received a letter from the Colonial Office informing me that it was the wish of the Secretary of State that I should comply with the desire of the Acting Governor of Fiji and attend the Conference as representative of the Fiji Government.

3. The Official Report (Colonial No. 45) gives a very full summary of the proceedings of the Conference so that, in my own Report, I have considered it necessary only to collect together and comment on those sections which, I think, are of direct interest to Fiji.

4. Most of the contributors to the discussions dealt with the diseases of temperate crops; on the whole, tropical crops, and especially those of interest to Fiji, received only passing mention.

5. A great part of the time was devoted to the consideration of the administrative side of Plant Protection Services. I have attempted to summarise the opinions which were put forward by various speakers and accepted by the Conference.

6. The basic assumption is that every country, and particularly every tropical country is entitled to take whatever measures it considers necessary for the protection of its crops.

7. The object of regulations shall be to control the movement of plant material into the country so that the possibility of introducing disease or pest is reduced to a minimum. In formulating such regulations consideration must be given to the economic effects of their introduction, *e.g.*, restriction of food plants would be impracticable. Consideration should also be shown to exporting countries which the regulations will effect and, in some cases, it might be advisable to obtain the views of particular exporters in those countries. The result might be the avoidance of unpleasantness and inconvenience by the imposition of unnecessarily strict restrictions.

8. A necessary preliminary to the formulation of regulations to protect any crop is a thorough knowledge of the habits of causal organism and a knowledge of the geographical distribution of the diseases.

The Conference expressed its appreciation of this fact in Resolution No. 6*. It was suggested that the Imperial Bureau of Mycology should issue lists or maps indicating the distribution of the more serious diseases of imported crops.

9. In order to keep the knowledge of disease distribution up to date, it was considered essential that each country should publish a list of the diseases with which they were afflicted and should promptly notify any change in the general plant disease situation or the appearance of any new disease.

It was suggested that some scheme of co-operation might be arranged on the following lines:—

(a) *Group notification.*—Countries geographically situated so that the transference of disease from one country to another was a potential danger should notify one another directly of any change in the plant disease situation.

These countries might also come to some agreement among themselves as to the treatment of any plant materials exchanged between them (Resolution No. 8).*

(b) All countries should notify any change in the plant disease situation to the Imperial Bureau of Mycology which would publish the information in the *Review of Applied Mycology* for general information, or, if necessary, inform interested countries directly.

(c) All new regulations, alterations or amendments should be promptly notified to group countries and to the Bureau of Mycology for general information.

For the information of Delegates attending the Conference, the Bureau of Mycology drew up a summary of the plant protection regulations in the Dominions and Colonies. This interesting document* is attached to this report.

10. Regulations to restrict the importation of diseased material should be based on the following principles:—

* Not printed.

(a) The importation of plants susceptible to the disease against which the regulations are directed may be prohibited either entirely, or from certain countries. Alternatively, they may be imported only with the permission of the agricultural authority who will decide in each case whether importation may safely be permitted, and under what conditions.

A number of delegates considered that total prohibition was the only safe method. It was generally agreed that the success of total prohibition would depend on the geographical situation of the country, the efficiency of the plant protection service and in general, the effectiveness with which the illegal importation of plants could be controlled.

(b) The plant material should be restricted to that necessary for propagation, should be imported only with the consent of the agricultural authority and should be retained under strict official quarantine until such time that it can be definitely decided that it is not affected with any disease.

This is the method which should be observed for the introduction of new stocks of a staple crop. Its success depends on the rigid observance of quarantine.

After discussion on this matter, the Conference passed Resolution No. 3.*

(c) Plant material may be admitted after being treated in some approved manner to render it innocuous. It was generally considered that, as far as fungal diseases and especially diseases due to filtrable viruses were concerned, this method would be most unreliable. Under certain conditions, it might be workable, but as a general principle, it was bad.

(d) The fact that a disease is already present in the country is not necessarily a justification for permitting the unrestricted entry of material infected with the same disease. The danger to be guarded against is the introduction of a new biological strain which might prove much more destructive than the strain already present. This has been exemplified particularly in the case of the rusts of cereals.

(e) Under certain conditions, the importation of infected material may be permitted if the disease concerned is not likely to endanger staple crops. This applies particularly to the importation of food plants. It should, however, be avoided if possible.

11. Much consideration was given to this matter of certificates to accompany imported and exported plant materials. This resulted in the adoption of Resolutions Nos. 7 and 7 (a).*

12. It was considered that a certificate should not be regarded merely as a guarantee of quality. It should be rather a document giving as much information as possible about the health of the consignment. A certificate should be given and accepted on this understanding.

13. It was unanimously agreed that it was a practical impossibility for the Mycologist, or any other officer, to certify, from inspection alone, that any particular consignment was free from disease.

14. It was considered that inspection of the crop in the field was of considerable importance in determining the freedom from disease of a consignment. It was considered essential where seed stock was concerned.

15. It was considered desirable that, if possible, some standard form of certificate should be adopted for use between countries of the British Empire. The certificate given in Appendix 1A of the Conference Report was adopted as a working basis, the intention being that it was to be circulated to the

* Not printed.

various Governments concerned for criticism. The following were the points emphasised:—

(a) The examination should be made as near as possible to the time of shipment, the exact time being noted on the certificate.

(b) A representative sample of the shipment should be examined.

(c) If possible the crop should have been examined in the field; this examination or its omission should be noted.

(d) The place where the crop was grown should be noted, this being considered to be of more importance than the place of export.

(e) A certificate of absolute freedom from disease is not required, but any disease or pest observed should be noted, whether specified in regulations or not. Where a special examination is made for any particular disease, this should be specifically noted.

(f) Any treatment to which the consignment has been submitted should be noted.

16. It was to be distinctly understood that the acceptance of this or any other certificate did not prevent the importing country from exercising its right to prohibit, quarantine, treat or otherwise deal with the consignment.

17. Regulation should be framed in such a way as to deal with any emergency that might arise, *e.g.*, the prevention of the entry of a diseased consignment should not be made impossible because the disease concerned is not included in some schedule.

18. A little discussion took place on the internal control of plant diseases.

Delegates from tropical countries agreed that most of their difficulties arose out of ignorance, lack of interest and absence of co-operation on the part of the planters—in most cases, natives. The primitive methods of cultivation—or lack of any method—were also considered to contribute towards the difficulties encountered. It was agreed that education of the planters by means of travelling instructors was the best means of combatting disease and that police methods were, on the whole, quite useless.

19. It was concluded that it was not desirable, nor, in fact, practicable to formulate standard regulations for general adoption. Each country must make its own arrangements, giving due consideration to the principles previously outlined, but it was thought that co-operation between countries which exchange plant products was highly desirable for the harmonious working of their respective plant protection services.

20. Mention was made of the grading of plant products. It was suggested that some standardisation of grading was necessary and that consideration should be given to the disease carrying potentialities of produce especially in connection with seed stock.

21. Continuing with other subjects dealt with by the Conference, the diseases of fruit shipped Overseas formed the subject for discussion at one of the meetings. Although most of the references were to the troubles experienced in the shipment of apples to England, and the work of the Low Temperature Research Station, a few references were made to the transport of bananas. These are given, though it is not considered that they add to the knowledge which we already possess.

22. Mr. Smith of Jamaica outlined the method of shipping fruit from the West Indies. The only variety shipped to any extent was the Gross Michel. The entire shipping was done by the Fruit Company and not by individual growers; this greatly simplified matters. The fruit was carefully graded, the particular grade sent depending on the destination. Thus, the less

mature fruit would be sent to Europe and the United Kingdom, more mature to New York and so on. The grades, which are selected so that the fruit will be ripening on arrival at its destination are:—

- (a) "bursting full," i.e., almost ripe;
- (b) "found full";
- (c) "Full three-quarter" in which the fruit is still ridged;
- (d) "Three-quarter."

The fruit is shipped in bunches of 6, 7, 8 or 9 hands. The grading and general condition of the fruit is checked frequently until loaded. Bunches are packed so as to give the maximum amount of ventilation. After loading, the hold is immediately cooled, the temperature being reduced to 52–55 degrees Fahrenheit in 3–3½ days by circulating cold air. The result is that very little transport trouble occurs. *Gleosporium* ripe rot is sometimes seen and occasionally a stem end rot associated with *Thielaviopsis*.

Cavendish bananas, if shipped, must be very carefully packed because they are much more readily damaged than the Gros Michel. Trouble is sometimes experienced with a rot associated with *Gleosporium* and connected with the persistence of the style in this variety. The Red Banana is shipped in the same way as the Gros Michel. Other varieties are not shipped as they ripen too rapidly.

23. Dr. Reichert described the following diseases of Cavendish bananas in Palestine:—

- (a) Tip End Rot caused by *Macrophoma musarum*;
- (b) Cigar End Rot caused by *Fusarium* sp.;
- (c) Steam End Rot, commencing at the stem end of the fruit, and associated with *Fusarium* sp. This condition appears to be identical with "Black End" of Fiji;
- (d) Rots caused by *Botrytis* and *Sclerotium*;
- (e) Rot of the entire fruit caused by a *Diplodia* and found only in fruit growing among oranges which are frequently affected with *Diplodia*.

24. According to Mr. Tomkins of the Low Temperature Research Station, much loss was experienced from rot due to *Thielaviopsis* in pineapples from the Azores.

25. On the subject of the Control of Insect Pests by means of Entomogeneous Fungi, the speakers were agreed that there was very little hope of securing economic control of insects by this means.

26. A paper was read by Mr. Bunting on the Deterioration of Produce by Moulds. I was unfortunately unable to attend the Conference on this occasion, but Mr. Bunting informed me that it was the intention of the Stored Products Investigation Station with which he was associated, to investigate the problem of the deterioration of copra by moulds. Mr. Bunting expressed his willingness to consider Fijian copra in his investigations and it is my intention to visit the Station at Slough, before my return to Fiji, to see if it will be possible to arrange with him some co-operative scheme.

27. The last matter which I think is of interest to Fiji is that mentioned in Resolution No. 2* on the provision of handbooks on the diseases of tropical countries. There are no adequate books on tropical diseases as there are for the diseases of temperate climates. The proposal is to supply this deficiency by means of a series of books published under the general editor-

* Not printed.

ship of the Bureau of Mycology and compiled by specialists on the various diseases. The volumes which would be of particular interest to Fiji are those on Cotton, Coconuts, Bananas and other Fruits, Cereals and Rice and Ground Provisions (which covers native food-stuffs, &c.)

Should Fiji be approached as suggested in para. 8 of the Committee's report, I would recommend the project to the Government for favourable consideration.

28. In conclusion I have only to add that I voted affirmatively to all the resolutions submitted to and adopted by the Conference.

PRESERVATION OF TIMBER.

THE following notes have been forwarded by Dr. J. D. Tothill, Director of Agriculture, Uganda:—

Papers have appeared recently in the *Journal of Industrial and Engineering Chemistry* on the subject of a new wood preservative said to be superior to Creosote. The method consists in soaking the air-dry timber in a solution containing the following materials:—

	Per cent.
Sulphuric acid	0.30
Zinc sulphate	3.00
Calcium acetate	2.10
Caustic Soda	0.75
Arsenic	2.25

After soaking, the timber is air dried and is then ready for use.

The note discussing this method states that—

"In January, 1928, the U.S. Department of Agriculture installed "a number of zinc meta-arsenite treated yellow pine posts on Barro Colorado Island, Panama Canal. When officially inspected in February, 1929, they were in perfect condition showing no decay and "no attack by white ants. Untreated yellow pine posts set at the same "time were completely destroyed. There are 36 species of tropical "termites on the island and the annual rainfall is about 130 inches."

SUBSIDIES FOR IMPORTATION OF LIVE STOCK.

IMPORTATION OF PEDIGREE AND GRADE CATTLE.

GOVERNMENT SUBSIDIES.

AT the meeting of the Legislative Council in May, 1930, approval was given for the increase of the subsidy on imported pedigree cattle and horses from £7 per head to £10 per head and of the payment of a subsidy of £5 per head on grade cattle of good quality. The rules governing the payment of subsidies are set out below:—

RULES REGARDING SUBSIDIES PAYABLE IN RESPECT OF IMPORTATION OF CERTAIN LIVE STOCK.

2.—(1) *Pedigree Cattle and Horses*.—A subsidy of £10 per head will be paid for each registered pedigree animal capable of breeding brought into the Colony. The subsidy will apply only to cattle which have attained the age of nine months and have not attained the age of five years and horses which have attained the age of nine months and have not attained the age

of eight years. An animal imported under the age of nine months, if otherwise qualified, shall be eligible for the subsidy on attaining the age of nine months.

Grade Cattle.—A subsidy of £5 per head will be paid for each female animal which has been registered, in the country from which it has been imported, as being the progeny of a registered pedigree sire and a dam which has been credited, by a Herd Testing Association, with having produced in one lactation period, the following amounts of butter fat (or over) according to age at the commencement of the test, viz.:—

as a 2 year old, 250 lb butter fat,
as a 3 year old, 275 lb butter fat,
as a 4 year old or older, 300 lb butter fat.

The subsidy will apply only to animals which have attained the age of nine months and have not attained the age of five years. An animal imported under the age of nine months, if otherwise qualified, shall be eligible for the subsidy on attaining the age of nine months.

(2) An animal must have been not less than one month in the Colony at the date of the application for the subsidy.

(3) Every importer of pedigree or grade animals, in respect of which it is intended to claim the subsidy, shall give one month's notice in writing to the Director of Agriculture of his intention to import, and shall state the number of animals to be imported.

(4) When applying for the subsidy, the importer will be required to state the country of origin and in the case of pedigree animals the particular herd or stud in which each animal is registered and to attach a certified copy of the pedigree or of the pedigree transfer certificate of each animal. In the case of grade animals the importer will be required to attach a certified copy of the heifer calf registration certificate.

(5) Before payment of the subsidy, each animal must have passed all quarantine regulations under the Animals Importation Ordinance 1886, and have been admitted to the Colony.

(6) The subsidy will not apply to animals which, in the opinion of the Government, have been imported for the purpose of sale. An importer who has been paid a subsidy or subsidies in respect of an animal or animals imported by him and who sells those animals within one year from the date of importation shall be liable to refund the whole or part of the subsidy.

(7) The total amount of subsidy payable to any importer in any calendar year shall not exceed £100.

(8) These Rules shall take effect from the first day of June, 1930.

FREIGHT RATES.

3. The freight rates on cattle imported from New Zealand by Union Steam Ship Company's steamer are as follows:—

Bulls	£8 10 6 each
Bulls (yearlings)	6 1 0 ..
Cattle 1, 2 or 3 head	5 10 0 ..
Cattle 4 head	5 4 6 ..
Cattle 5 head	4 19 0 ..
Cattle 6 head or more	4 13 6 ..
Calves up to 9 months	One-third off cattle rates
Calves under 1 month	Free.

PRE-SHIPMENT CONDITIONS.

4. Cattle imported from New Zealand must be accompanied by—
- (1) a statutory declaration by the shipper giving a description of the animals and certifying—
 - (a) that the animals have been free from disease during the six months preceding the date of shipment;
 - (b) that they have not been in contact with any diseased animals during the six months preceding shipment and giving the name of the district in which they have been during that time;
 - (c) that they have not, otherwise, than is required by (2) below, been tested with tuberculin during the two months preceding shipment;
 - (2) a tuberculin test certificate by a qualified Veterinarian endorsed by the Chief Veterinary Officer of the Department of Agriculture of the State concerned. The certificate shall state (*inter alia*) the date on which the test was applied;
 - (3) a certificate from a Government Veterinarian or Veterinarian employed in an official capacity by a local Government authority stating—
 - (a) that he has examined the animals within seven days of shipment and found them to be free from disease; and
 - (b) that they have been dipped or thoroughly sprayed within thirty-six hours of shipment with a standard arsenical anti-tick solution, the name of the preparation to be given;
 - (c) that the agglutination test for contagious abortion has been applied with negative results within fourteen days of the date fixed for shipment.

QUARANTINE.

5. Cattle imported from New Zealand are required to undergo a period of quarantine of seven days. The regulations provide that they shall be dipped whilst in quarantine.

NOTICE OF IMPORTATION.

6. They may be imported through the port of Suva only. *The importer is required to obtain, not less than one month prior to the date of arrival of the cattle, the written permission of the Superintendent of Agriculture to import.*

FEES AND OTHER CHARGES.

7. Inspection and other fees payable in the Colony are as follows:—

Wharfage	1/6 per head
Port and Customs Service Tax	1 per cent. of value

Inspection Fees—

For one and not exceeding four head ..	£1 1/-
For every additional head over four and not exceeding fifty	2/-
For every additional head over fifty ..	1/-

Transport Fees—

For each trip of the cattle punt from the ship to the Quarantine Station ..	10/-
---	------

Dipping Fees —

Cattle over six months old	5/- per head
Cattle six months and under	1/- per head

When six or more cattle are imported by any person at any one time, reductions will be made in the dipping charges as follows: —

<i>Numbers.</i>	<i>Reduction in Fees.</i>
From 6 to 10	10 per cent.
From 11 to 20	20 per cent.
From 21 to 50	33½ per cent.
Over 50	50 per cent.

Upkeep and Sustenance Charges whilst in Quarantine—

Cattle one to four (per head)	3/- per diem
Each animal above four (per head) ..	1/- per diem.

EXAMPLES:

8. The total charges connected with freight, wharfage, inspection, transport, dipping and sustenance would be, on the rates shown above (which are subject to alteration), as follows: (Port and Customs Service Tax is not included as it is not possible to calculate the charge without the value of the animals being known):—

One Adult Bull from New Zealand: Subsidy on one pedigree bull on conditions already stated £10

Freight	£8 10 6
Wharfage	0 1 6
Inspection Fee	1 1 0
Transport Fee (if no other stock on board for transport to the Quarantine Station)	0 10 0
Dipping Fees	0 5 0
Sustenance Charge, 7 days at 3/- per diem	1 1 0
	<hr/>
	£11 9 0

One Yearling Bull from New Zealand: Subsidy £10

Freight	£6 1 0
Wharfage	0 1 6
Inspection Fee	1 1 0
Transport Fee	0 10 0
Dipping Fee	0 5 0
Sustenance Charge	1 1 0
	<hr/>
	£8 19 6

Six Pedigree or Grade Cows or Heifers over 9 months of age—

<i>Subsidy in respect of pedigree animals</i>	<i>£60</i>
<i>Subsidy in respect of grade animals</i>	<i>£30</i>

Freight at £4 13s. 6d. each	£28 1 0
Wharfage	0 9 0
Inspection Fees	1 5 0
Transport Fees	0 10 0
Dipping Fees	1 7 0
Sustenance Charges	4 18 0
	<hr/>
	£36 10 0

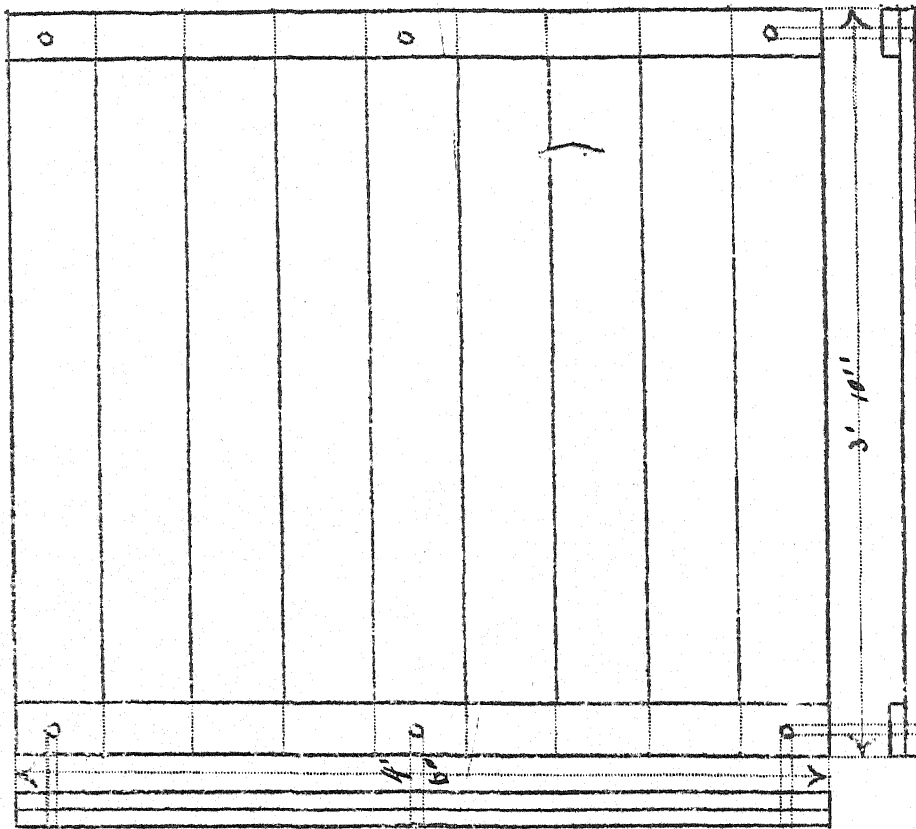
Bolt Holes

Side
Elevation

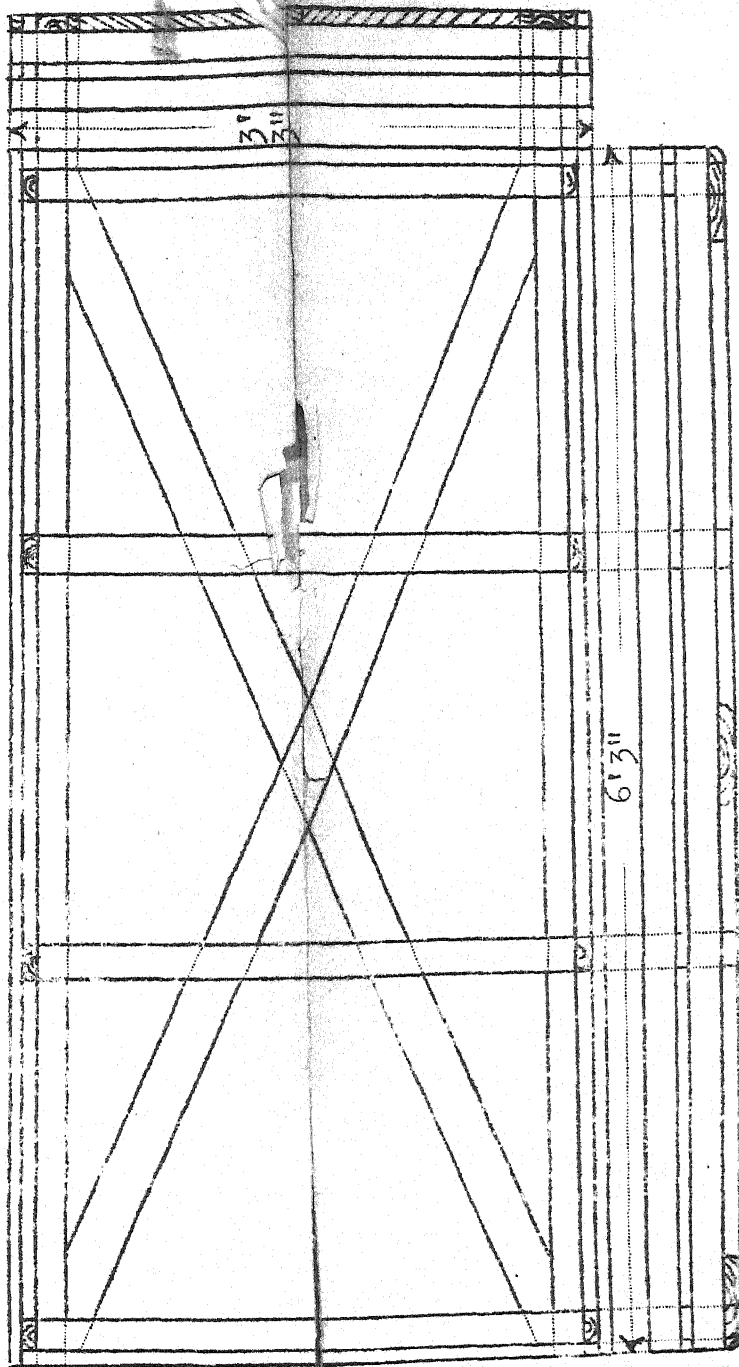
Bolt Holes

Bolt Holes

3' 10"



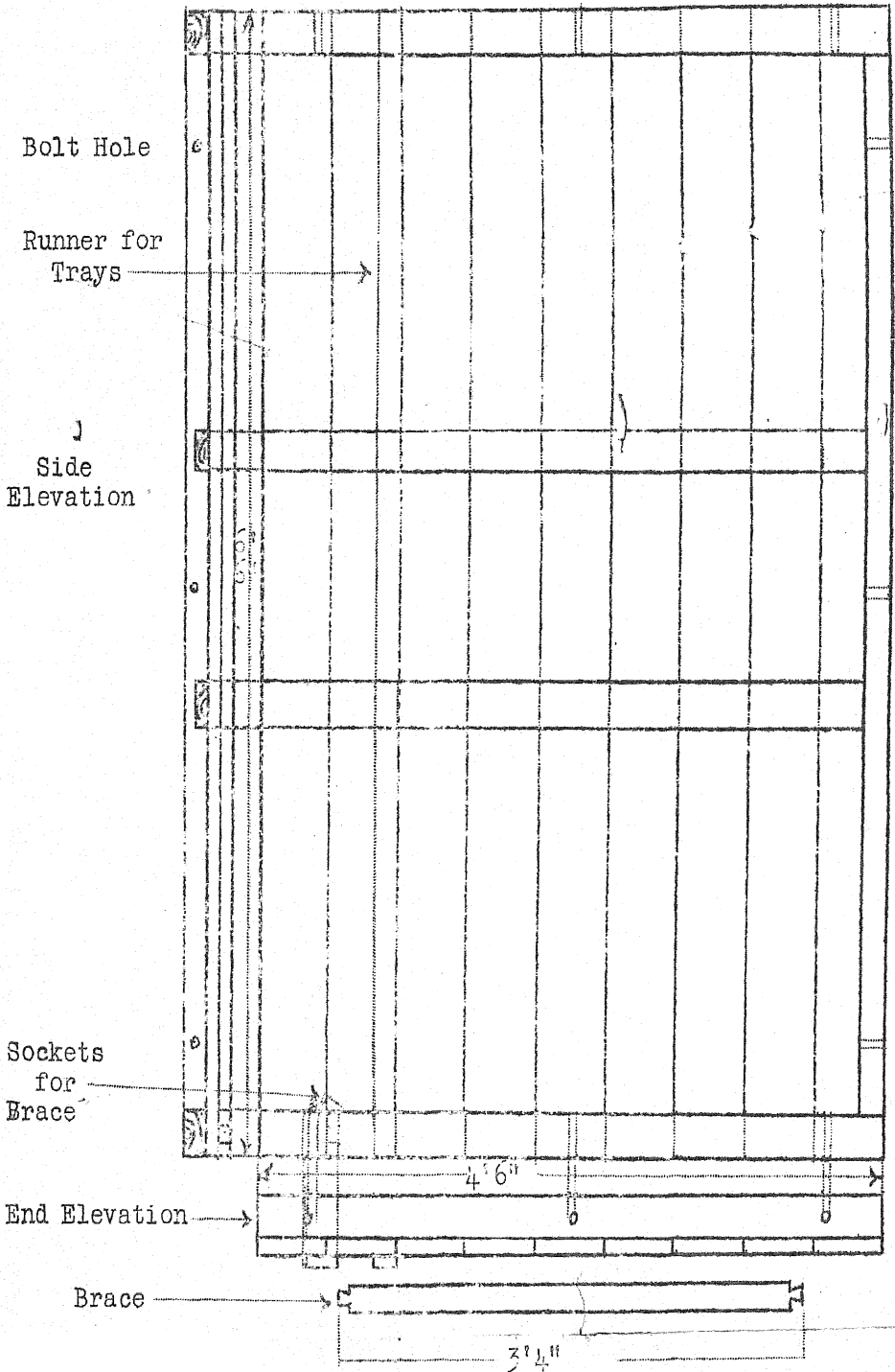
PLAN OF TRAY



Runners Side Elevation

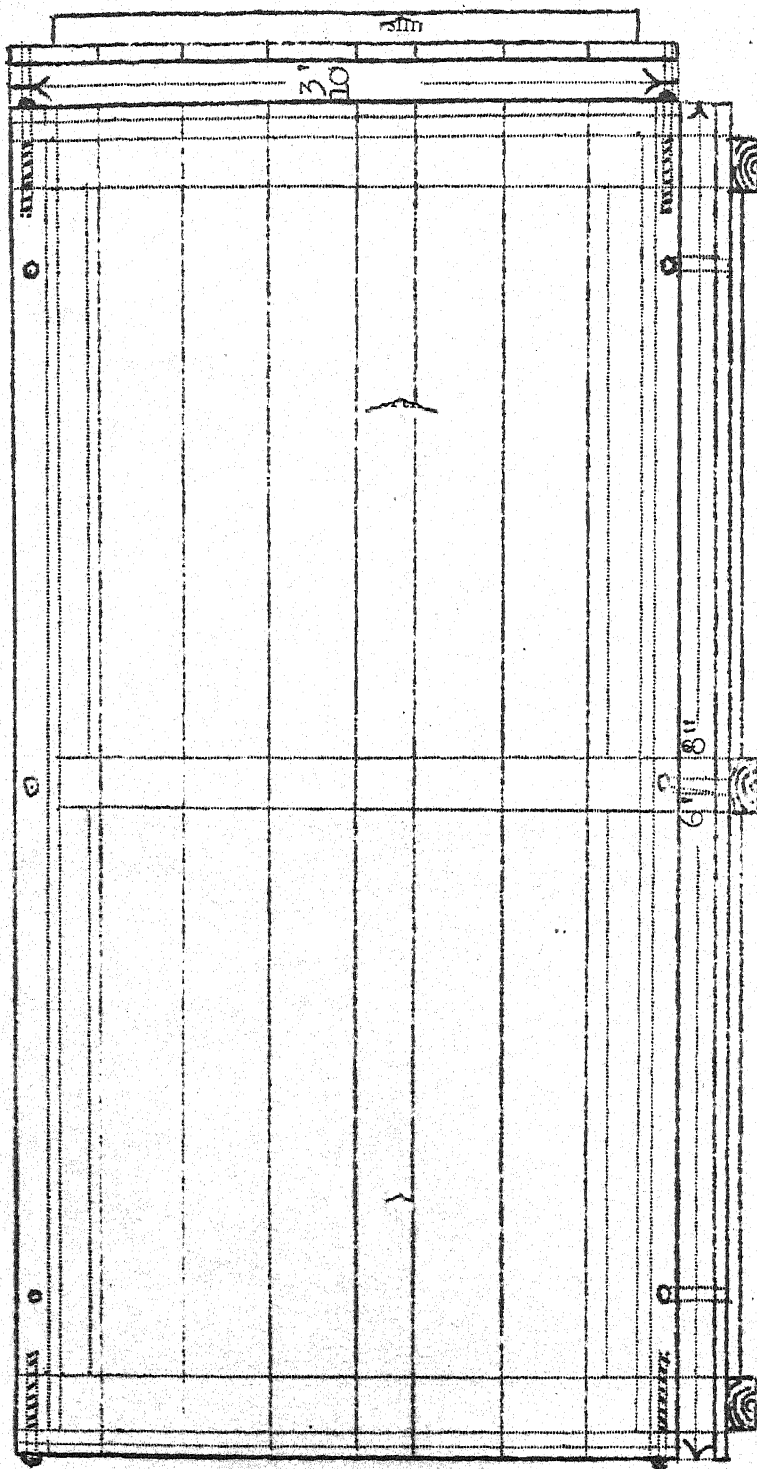
Note: 6 trays required 6" deep
1 tray required 5" deep

PLAN OF SIDE



COPRA SULPHURING CHAMBER.

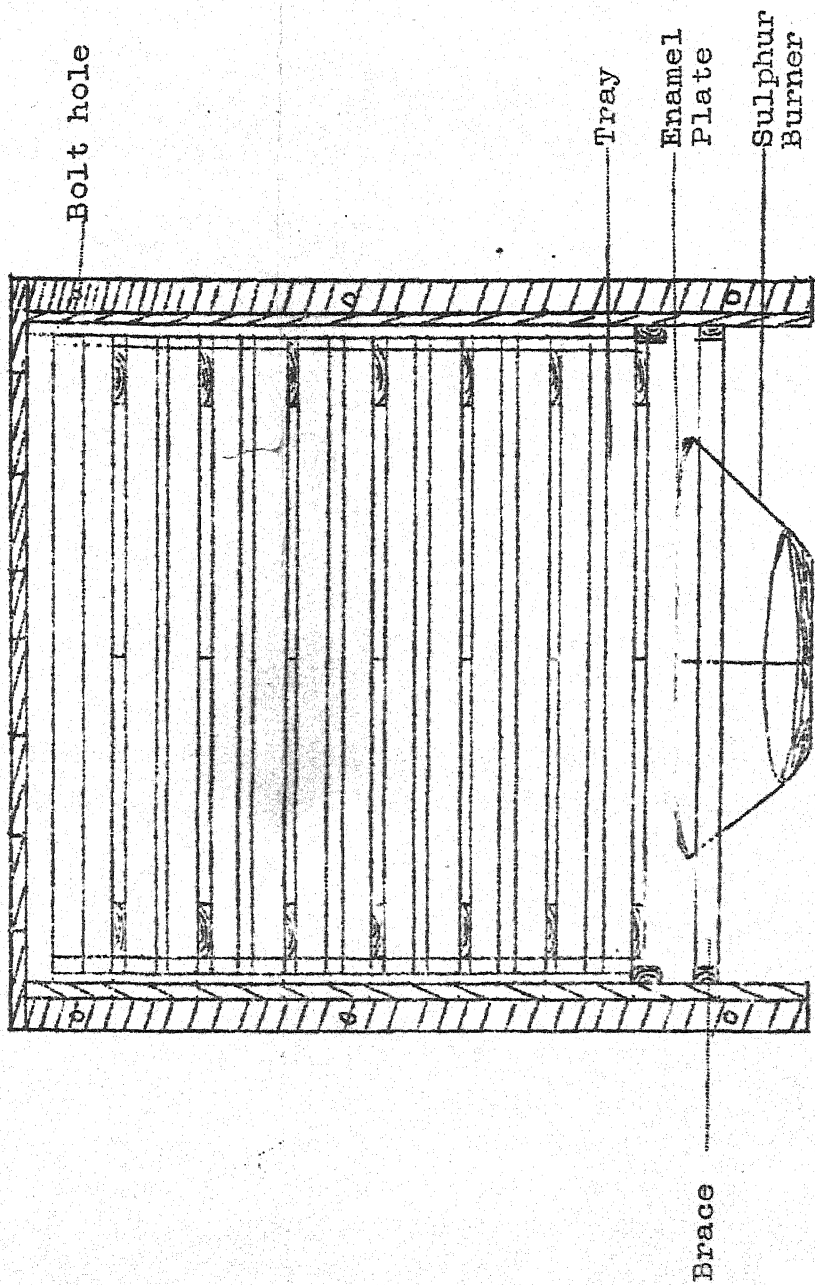
Plan of Roof



Side Elevation

SULPHUR CHAMBER LOADED

One end open.



Twenty Pedigree or Grade Cows or Heifers over 9 months of age—

<i>Subsidy in respect of pedigree animals (limit)</i>	..	..	£100
<i>Subsidy in respect of grade animals (limit)</i>	..	..	£100
Freight at £4 13s. 6d. each	..	£93 10	0
Wharfage .. .. .	..	1 10	0
Inspection Fees .. ..	..	2 13	0
Transport Fees .. ..	..	0 10	0
Dipping Fees .. ..	..	4 0	0
Sustenance Charges ..	..	9 16	0
		£111 19	0

Twenty Pedigree or Grade Heifers under 9 months of age—

<i>Subsidy pedigree animals (on attaining 9 months) (limit)</i>	£100
<i>Subsidy on grade animals (on attaining 9 months) (limit) ..</i>	£100
Freight at £4 13s. 6d. less $\frac{1}{3}$	£62 6 8
Wharfage	1 10 0
Inspection Fees	2 13 0
Transport Fees	0 10 0
Dipping Fees (over 6 months)	4 0 0
(Six months or under the charge would be 16/-)	
Sustenance Charges	9 16 0
	£80 15 8

FII LIVE STOCK RECORD ASSOCIATION—MINUTES OF MEETING.

MEETING HELD ON 11TH JULY, 1930.

Present.—Director of Agriculture (Chairman), Senior Veterinary Officer, G. Kiss, Esq., and J. Barber, Esq.

Owing to an oversight R. Craig, Esq., was not advised of the meeting.

The minutes of the last meeting were read and confirmed.

The Chairman drew the attention of members to an article on livestock in Fiji prepared by the Senior Veterinary Officer for publication in the *International Register of Pedigree Stock Breeders*, and stated that a copy would be made available to members for perusal on application.

The Chairman stated the action taken by the Government towards assisting importers of pedigree and grade stock and stated that a memorandum on the subject would be distributed in due course.

The Board directed that an effort be made to exhibit a list of the members of the Association, particulars of animals registered, &c., in the Agricultural Department's exhibit at the Suva Show. The Secretary was instructed to take the necessary steps to carry out this instruction.

Mr. Kiss suggested that the Association should open a Calf Register and that animals registered therein should not be transferred to the main Register until after they had been inspected and passed as suitable for inclusion. The Board directed that this matter should be considered at a later meeting.

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Vol. 4.]

1931.

[No. 1.

AGRICULTURAL JOURNAL

*Issued by the
Department of Agriculture, Fiji.*

PRICE, ONE SHILLING.

BY AUTHORITY: H. CRAIGIE, ACTING GOVERNMENT PRINTER, SUVA.

1931.

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 4.]

FIRST QUARTER, 1931.

[No. 1.

EDITORIAL.

IT should be noted that this number is the first issue of Volume 4 of the *Agricultural Journal* and that Volume 3 was completed by the third number published in October, 1930.

Agricultural Convention.—This function was opened by His Excellency the Governor on October 7th, 1930, when a large and representative gathering met in the new Fiji Museum. The subjects considered during the three days devoted to the Convention included dairying, the copra industry, banana production and export, noxious weeds, and minor crops. Contributions to the discussions came from all sections of the agricultural community, and information of value was obtained. The wider basis on which the Convention was organised should enhance its usefulness, and the addresses by those gentlemen who so kindly consented to introduce the different subjects evidenced deep study and a wide appreciation of the agricultural activities of the Colony. The proceedings of the Convention are published in this issue.

Bananas.—The new arrangements for inspection of bananas at the wharf continue to work well, and it is gratifying to record that reports from Auckland state that the quality of the fruit now shipped is excellent. Good prices have been obtained for recent shipments. The handling of cased fruit on the wharf has been greatly facilitated by the use of Morris Conveyors, which should considerably reduce damage by shaking and bruising. The output of bananas has received a further setback by three storms, the first of which occurred on November 23rd, 1930, and affected principally the Wainibuka district, while the others occurred very close together in late February and early March, 1931, and affected much wider areas. At the time of writing it has not been possible to ascertain the actual extent of the damage to bananas and other growing crops, but it is known to be serious and it is feared that fruit exports will be considerably below normal for some months. The banana districts which suffered were the Wainibuka, Wainimala and, to a lesser extent, the Waidina Rivers. The output from the island of Kadavu has increased rapidly and it is expected that the monthly export will soon reach 2,000 cases.

Banana Buyers' Licences, excepting the one issued for the province of Kadavu, expired on the 31st December, 1930. New licences have been issued for all other areas, excepting Ovalau, Moturiki and Gau. A few minor changes have been made, particularly in regard to the Waidina River, which is now shared by the Dominion Fruit Company and the Waidina Banana Syndicate (Messrs. Barber, Abbott and Message). The island of Koro and portion of the Savusavu magisterial district have been proclaimed under the Fruit Export Ordinance and licences will be issued for these areas.

Animal Health.—The discovery of a species of tick (*Hæmaphysalis bispinosa*) hitherto unknown in Fiji has rendered it necessary to restrict the movement of cattle in and from the area bounded by the Lower Rewa

and Tamavua Rivers. The veterinary staff, assisted by a temporary staff, is engaged on the work of inspection and spraying of animals within the area in an endeavour to eradicate the tick. Fortunately, the tick is not a disease carrier, but it causes loss of condition in animals and is therefore objectionable.

FIJI AGRICULTURAL CONVENTION.

October 7th and 8th, 1930.

President.—His Excellency Sir Murchison Fletcher, K.C.M.G.

Chairman.—A. C. Barnes, Esq., Director of Agriculture.

Members of Committee.—Edward Duncan, Esq., Fiji Show Association; J. L. Hunt, Esq., Fiji Planters' Association; Major Clive Joske, M.C., Coconut Planters' Union Limited.

Secretary.—N. G. J. McNally, Esq.

Participating Bodies.—Buca Bay Progress Association; Coconut Planters' Union Limited; Fawn Harbour Progress Association; Fiji Planters' Association; Fiji Show Association; Savusavu West Progress Association; Vanualevu Progress Association.

AGENDA.

Tuesday, October 7th, 2.15 p.m.

1. Opening Address by His Excellency the Governor.

Motion No. 1.

2. "The Present Position and Prospects of the Dairying Industry in Fiji"—Address by J. Chapman, Esq.

Discussion opened by A. H. Witherow, Esq.

Motion No. 2.

Wednesday, October 8th, 9.30 a.m.

3. "The Copra Industry"—Address by E. Duncan, Esq., and Major Clive Joske, M.C.

Discussion opened by Sir Maynard Hedstrom.

Motion No. 3.—Major Willoughby Tottenham.

2.15 p.m.

4. "The Banana Export Industry"—Address by A. C. Barnes, Esq.

Discussion opened by A. H. Witherow, Esq.

5. "The Control of Noxious Weeds in Fiji"—Paper presented by A. C. Barnes, Esq.

Discussion opened by J. L. Hunt, Esq.

Motion No. 4.—E. Duncan, Esq.

6. Closing Address by His Excellency the Governor.

Note.—(1) Meetings will be held in the new Fiji Museum (Carnegie Library Buildings).

(2) Gentlemen who wish to take part in discussions are requested to notify the Secretary prior to the meetings.

(3) If time permits, the production and marketing of minor crops will be discussed.

MOTIONS.

1. That in the opinion of this Convention it is desirable that the Agricultural and allied Associations of the Colony of Fiji should form themselves into a Convention of Associations which should hold an annual meeting to discuss and consider matters of interest to the primary industries of the Colony.

2. That this Convention appreciates the assistance afforded by Government to the dairying industry of the Colony by the increase and extension of the system of subsidies on pedigree and grade stock and welcomes the proposal to pay a subsidy on butter exported from the Colony.

3. That in the opinion of the Convention the position of the copra industry gives cause for disquietude and that the possibilities of securing increased returns to producers should be explored, such as by increase of yield, the reduction of production and transport costs, and the introduction of a system of Government grading.

4. That in the opinion of this Convention a more active campaign directed to the control of noxious weeds in Fiji should be pursued.

His Excellency the Governor in opening the Convention said that he had been present throughout the proceedings of the Conference which was held in January, 1930, and that he regarded these Conferences as of great importance to the welfare and progress of the Colony. It was a trite saying that without agriculture there would not be anyone in Fiji at the present day. There were many ways in which not only agriculture could be improved but also the means of marketing.

His Excellency then briefly referred to the Agenda and said that with regard to Motion I it was a most important preliminary step to form some central body so that there should not be isolated bodies coming as they did from time to time to the Government and asking for assistance. He had suggested to the Indian community that they themselves should form a separate Agricultural Association to place their difficulties before the Government.

He said he was intensely interested in the subject of the present position and prospects of the dairying industry in Fiji, and that he had taken the opportunity when in Sydney of making inquiries there. He felt confident that Fiji was at the beginning of a really important new industry. The Government would do all in its power to assist the dairying industry. He drew attention to the motion which dealt with the proposal to pay a subsidy on butter exported from the Colony. He mentioned that this matter was in the Budget coming before Legislative Council. He himself did not consider that the subsidy should be paid for an indefinite period or any too long a period. He drew attention to the Patterson Scheme in operation in Australia whereby every producer paid $\frac{1}{2}$ d. per lb on all butter produced. The selling price in Australia was fixed by the producer and the $\frac{1}{2}$ d. per lb which they paid to the fund enabled a bounty of 4d. per lb to be paid on all butter exported. He remarked that he had only casually investigated the Scheme but should like to follow it up for possible adoption in Fiji.

Speaking on the copra industry and the motion to be moved by Major Willoughby Tottenham His Excellency said that he did not agree with him as to the cause for disquietude. He concurred that at the moment the bottom seemed to have fallen out of the market but on looking at figures for 20 years ago he found that the same condition of affairs existed then. He felt certain that Fiji was about to turn the corner. With an industry such as this which was one of the most important industries of the world he felt certain that conditions would improve but it was quite true that we had to secure increased returns. He mentioned that this matter had been discussed at length at the January Conference, but he would like to hear further discussion on the question. His Excellency then referred to the motion dealing with a reduction of production costs and transport costs. Transport costs were at the root of everything in this Colony—

transport costs and means of communication. He said that although times were bad he was trying to push on with the road round the island but he was afraid that it was not possible to do much at present.

Speaking on the production of minor crops he remarked that the principal text of the note was connected with Motion No. 1, allied Associations and the question of transport. It was absurd that a Colony with such an excellent soil and climate capable of producing minor crops should find that there was absolutely no market for them. The Government with the assistance of the Director of Agriculture would explore every possibility of establishing some central marketing arrangements whereby the small producer could get a good price for his crops. He entirely agreed with this important motion.

With regard to the banana export industry His Excellency said that this was a matter of the greatest importance and it was unfortunate that there were diseases to contend with. The Government had seconded a Cadet who had a long training in agriculture in England, for the purpose of studying these banana diseases and he sincerely hoped that some advance would be made in their control. There were many questions of the greatest interest connected with the banana industry and one in particular was the system by which the purchase of Fijian bananas was carried on. There was also the question of the Indian growers to be considered. He hoped that the Convention would do something to indicate to Government the proper path to take. Speaking on the subject of control of noxious weeds His Excellency said that on "Koster's Curse" the Thrips were being tried and it was having some success. In connection with this matter there was the question of employing more labour and more mechanical appliances, ploughs, tractors and so on. His Excellency in conclusion expressed his regret that very great pressure of business would prevent him from attending throughout the whole of the sessions.

Mr. Duncan moved Motion No. 1 as follows:—

That in the opinion of this Convention it is desirable that the Agricultural and allied Associations of the Colony of Fiji should form themselves into a Convention of Associations which should hold an annual meeting to discuss and consider matters of interest to the primary industries of the Colony.

Speaking to this motion *Mr. Duncan* said that this was the sort of Association that had been aimed at for many years. *Dr. Tothill* made a very strong effort to form one but unfortunately he was unsuccessful. He considered that the various Associations acting alone were not likely to achieve much success.

Major Willoughby Tottenham in seconding the motion said that he endorsed the necessity for such an Association.

Mr. Barker said that a similar suggestion had been made four or five years ago. The assistance of the Government had been obtained, and the Superintendent of Agriculture, *Dr. Tothill* had taken a keen interest. Rules had been prepared for a so-called Agricultural Society. Most of the Associations in question at that time favoured the proposal, but one district strongly objected, and on that account *Dr. Tothill's* efforts did not succeed.

Major Joske said that his Union was mainly concerned with marketing and shipping organisation, but that he was sure all members would heartily support the proposal. Most of the participating bodies with the exception of the Fiji Show Association and the Fiji Planters' Association were coconut planters' organisations and they would welcome the idea. The time might come when the Convention would go from district to district and perhaps

the Government would place at its disposal the "Pioneer" so that meetings could be held in other places in the Colony.

Mr. J. L. Hunt stated that all the Associations, including the Planters' Association would be keen to join the Convention and form one body which would give the views of the Colony. This had been the aim of the Planters' Association for many years. He mentioned that there used to be a Convention of planters consisting of 196 members with branches in not less than five districts, but owing to lack of communication it was difficult to keep in touch with them all. He suggested that the meetings be held from time to time in different districts of the Colony.

Mr. Barnes said that a motion of this description did not mean that the Associations already existing would lose their individuality. It was hoped that they themselves would continue to exist and extend but if they had some central controlling body they could go to Government backed by the general body of opinion, and this course would carry very much more weight. Under present circumstances Government received complaints, suggestions and recommendations from individual Associations such as those listed, but there was no proper communication between those individual Associations and the Government such as would be provided if a representative Convention were formed.

His Excellency said that he agreed with Mr. Barnes that it was not intended to do away with any of the separate Associations. He instanced Ceylon where they had both the individual Planters' Union and a Great Planters' Union of Ceylon. The district Association represented their views and difficulties to the parent body.

Motion No. 1 adopted.

Mr. J. Chapman addressed the Convention on the dairy industry as follows:—

I have been asked to prepare a paper on the "Present Position and Prospects of Dairying in Fiji." I speak with some diffidence: firstly, because my residence in Fiji has, extended only for a period of six years; and secondly, because my experience in the dairying industry has been confined to the Navua district and I have very little knowledge of the condition of affairs in connection with the Rewa and Tailevu districts. Each district must have its own peculiar problems, but there are certain larger questions which must confront all dairy farmers in this Colony, as they have in the past confronted those engaged in the dairying industry in other countries.

Improvement of Herd.—I think probably the most serious problem is the question of improving the breed of cows so as to increase the production of butter fat. Most of the dairy herds in the Colony have been built up on the foundation of local cows. I know that at Navua we bought large numbers of Fiji-bred cows—most of them of no particular breed—many of them allied to beef breeds rather than to milking stock. On the basis of these local herds we are attempting to produce a herd of good milking cattle and with that object in view have imported a number of pedigree bulls, both of Jersey and Friesian breeds. We have now a considerable number of cows of the second generation (*i.e.*, three-quarter pure breed) and the improved results with this young stock are encouraging. We are building up two separate herds—one of them sired by Friesians and the other by Jerseys—and our intention is ultimately to eliminate the Fiji-bred cow of indeterminate descent. This can only be done by a process of selection and elimination and that process is going on steadily all the time, but up to the present the elimination has been done purely on observation and

inspection, we have had no scientific method of herd-testing. After considering this question the Fiji Pastoral Company recently engaged a qualified herd-tester, recommended by the New Zealand Herd Testing Association, and he is at present engaged in tattooing all our cows, according to the New Zealand system, prior to starting a systematic test. It is hoped that by this method we will ascertain with some accuracy the cows which are proving unprofitable. They will be speyed and turned into the beef herd.

The Company's dairy herd consists of over 1,000 females and these are distributed in about equal proportion of Friesian strain, Jersey strain and local stock. We cannot state with any degree of accuracy what is the production of butter fat per cow, but our estimate is about 150 lb per cow per annum. If we can eliminate from the dairy herd, say, 20 per cent. representing the most unprofitable beasts in the herd the average production of those remaining will be substantially increased and we hope that the rejected cows will be replaced by three-quarter bred heifers which again should give a return considerably above the average of the whole herd. If we can increase the average production per head we will at the same time increase the average production of butter fat per acre of land—and that is the biggest problem which faces the dairy farmer in Fiji. With careful selection of sires and the scientific elimination of the unprofitable the average production of the herd must increase. This question is of first importance to every dairy farmer, whether his herd be large or small. The small farmer cannot engage his own herd-tester, but it would seem worth while to consider in each district some form of co-operation whereby the farmer may obtain accurate records of the individual production of each cow he is milking.

Improvements of Pastures.—The next most important problem is the improvement of our pastures so as to increase the carrying capacity and production of butter fat per acre. I am not qualified to speak with any authority regarding the fodder grasses of Fiji as my experience has practically been limited to two fodder plants—Para Grass and Sensitive Grass. Most of the land we are farming at Navua was formerly under sugar and, to some extent at least, before the sugar industry was finally abandoned the land was neglected and impoverished. When dairying operations were commenced an endeavour was made to preserve the para grass which was growing freely on all the flat land but in this effort we have not been successful. We have gone to considerable expense with the sub-division of paddocks and the extent of our fencing will be realised when I tell you that we have forty-seven miles of barbed wire cattle fencing. Notwithstanding this the area under para grass is steadily diminishing and its place has been taken by sensitive. On the low-lying Bila land which is constantly refreshed by flood water para holds its own—even with heavy feeding, but on the abandoned sugar land it succumbs very readily and, as I have said, its place is taken by sensitive. I was very apprehensive when I saw the gradual decrease of para and the increase of sensitive but I have become reconciled to that condition—the sensitive stands very heavy feeding, cattle take to it quite readily, and at present a very large percentage of the butter fat produced at Navua is produced from sensitive grass. I do not suggest that sensitive grass is an ideal cattle food. We have made experiments on a small scale with English grasses and with Paspalum, but the results have not been sufficiently encouraging to justify any heavy expenditure. It would be an excellent thing for the dairy farmers of this Colony if we could discover some grass which would flourish and afford a change of diet and pasture for the milking cows. I cannot help thinking that there must be tropical or semitropical grasses that would be suitable

to our climate and I am looking forward with interest to the experiments contemplated by the Agricultural Department.

Linked up with this question of improvement of pasture is the question of manuring. We have made some small experiments with artificial manures and the results have been encouraging when coupled with a heavy stroke of the disc harrow—areas thus treated showing a marked and sustained improvement. Top dressing without discing does not yield any apparent result. We have not continued these experiments because we have felt that we are working in the dark and that we may easily spend a large amount of money without producing a proportionate return. We have not at our hand the scientific knowledge to decide what elements are missing in our soil and what class of manures should be used to give us the best return in cattle feed. We hope that later we may be able to get technical advice on this subject and I am sure that many dairy farmers will be glad to make small areas of land available for practical experiments with various classes of manures.

The Control of Noxious Weeds.—Our worst pest at Navua is that commonly known as "Koster's Curse," and I understand this is true also of the Rewa district and the Tailevu district. During the past few years we have spent many hundreds of pounds in an endeavour to eradicate this weed. On the main areas we have obtained some measures of control and the expenditure per acre for Curse cutting is very much lower now than it was two or three years ago. We still have a good deal of trouble on areas near our boundary lines because in most cases our neighbours take very little interest in the eradication of this weed and from neighbouring lands the seeds are freely replanted in our fields. I know the Agricultural Department is taking great interest in this question and it would greatly improve the prospects of the industry if we were able to find some natural enemy for this Curse. By the courtesy of the Agricultural Department we have started two colonies of Thrips at Navua but the time which has elapsed has not been sufficient to disclose whether any useful work is being done.


Milking Machines.—In Fiji, as in New Zealand, opinions differ as to the advisability of machine milking. My opinion is that in New Zealand the argument is in favour of the machine, but my experience at Navua has led me to form the opinion that as long as Indian milkers are obtainable we get better results from hand-milking than from machine-milking. We had machines installed in three sheds but have dismantled them and packed them away. To obtain superfine cream from machine milkers one must have the most meticulous care and cleanliness and I have not been able to obtain this from Indian assistants. To run milking machines efficiently I consider they must be under close European supervision and as we have eight milking-sheds scattered over a radius of about three miles from the factory, European supervision would be expensive.

Government Assistance.—The Government has already shown its interest in the industry and in one particular district has expended a very substantial amount of money in its development. There are some directions in which we must naturally look for Government assistance and support:—

- (a) I understand the Government is contemplating a bonus on butter exported and the creation of a Butter Control Board. Provided all interests are represented on the Board I think this will be a very wise move;
- (b) the Agricultural Department, as I have mentioned earlier, is taking a keen interest in finding some method of economically controlling "Koster's Curse";

- (c) the Agricultural Department is considering by-laws to govern milking sheds, factories, &c. So long as these are reasonable and do not at once set too high a standard they are likely to be productive of good, but we must learn to walk before we can run;
- (d) the Government is interested in the improvement of stock and has made provision to assist importers who desire to introduce pedigree stock;
- (e) I hope the Government will take a keen interest in the question of the improvement of our pastures, both in the direction of experimenting with new grasses and technical consideration on the subject of manures.

The Future of the Industry.—I think that we must judge the prospects of the future largely by the history of the past. According to records kept by the Agricultural Department the following figures show the production of factory butter in Fiji for the past nine years:—

Year.	Amount. (lb) 
1921	15,104
1922	23,785
1923	59,219
1924	143,219
1925	168,844
1926	247,724
1927	295,677
1928	307,989
1929	392,214

The percentage increase is not likely to be as great in the future as in the past, but there is every prospect of a steady, solid advancement year by year. In the Rewa district particularly, considerable enterprise has been shown in the introduction of high grade stock and this must have in the very near future a substantial effect on our production. We have substantial areas of land on this island which can be made suitable for cattle grazing and for dairying which otherwise would lie useless and covered with weeds. Such land is obtainable at moderate rentals so that the dairy farmer in Fiji has at least that advantage over the New Zealand dairy farmer. I suggest that the work of the past nine years has demonstrated:—

- (a) that various breeds of dairy cattle can readily be acclimatised here and remain as healthy and free from disease as in any other part of the world;
- (b) that the progeny of imported stock (provided they are suitably mated) are superior to their sires and dams, probably because they do not need to undergo the process of acclimatisation;
- (c) that high grade butter, suitable for export to any market, can be produced in this Colony.

Having these three factors fixed I think it only needs energy intelligently applied to insure the steady progress of the industry.

In conclusion, I should like to say that I am more favourably impressed to-day with the chances of success that I was when first I arrived in the Colony.

Mr. A. H. Witherow in opening the discussion said the production of the maximum quantity of butter fat was of prime importance and this could only be done by good feeding and by having pedigree bulls with high

butter fat backing. Herd testing was also very necessary. The dairying industry was suffering from great drawbacks. There were the absence of varieties of good fodder plants for our pastures, the difficulty in obtaining land at reasonable rentals, and the obstacle of noxious weeds. Mr. Witherow then touched on the question of cheese making and said that with a little protection from the Government this could be carried out quite profitably.

Mr. Meek considered that ghee-making should be investigated. Another point he would like to mention was the enormous loss to the dairy farmers through carrying in their herds diseased animals.

Mr. McElwaine said that he had been interested in dairying since its inception in the Colony and he considered that pasture was the most important thing that was holding back the progress of dairying within the Colony. He said that another important point was the subsidy paid by the Government on pure bred bulls and cows which was £10 per head. This sum practically covered the whole of the expense of bringing the animal from New Zealand with the result that dairymen in Fiji are on the same footing as dairymen in New Zealand. More rapid transport of cream from farm to factory was necessary.

Mr. Turbet said he shared with the previous speakers the optimism for the future of the dairying industry. He remarked that he would support at least the temporary appointment of an official herd-tester. With regard to pure bred bulls, Geneticists and animal breeders had found that a bull transmits his ability for milk producing to the female line rather than to the male line and that a bull should not therefore be judged on his pedigree but by the results of his heifers. Mr. Turbet went on to say that for many years experiments in connection with pasture grasses from temperate zones had been carried out by the Agricultural Department and private individuals and sufficient information had been gathered to say that these countries had no grasses suitable for our conditions. It was necessary to turn to tropical and sub-tropical climates such as Hawaii, and the Philippines. He mentioned that there were two serious diseases in the dairy herds, tuberculosis and contagious abortion. A move had been made to eradicate tuberculosis from the registered dairies in the Suva district. Rules were being drawn up for compulsory testing for tuberculosis. This was only a beginning but before long he hoped to see it extended to the three areas supplying milk to the factories. Contagious abortion was chiefly apparent at Navua, but it was also on some of the Tailevu farms and on at least one Rewa farm. Steps were being taken to control the disease restricting the movement of cattle from the affected farms. He said that the efforts had been fairly successful and he hoped that eventually the disease would be eliminated.

Mr. Fernandez discussed the freight on exported butter. The Union Company charged 3s. 9d. per box from Suva to Auckland and the freight from Auckland to England was 3s. 6d. With regard to the production of butter at the Rewa Factory he said that in 1925, 58,000 lb of butter were manufactured at a cost of 4½d. per lb, for the year ended 1927, 104,000 lb at a cost of approximately 3½d. and for the year ending June, 1930, 133,000 lb at a cost of 2½d. Thus the larger the production the lower is the cost of manufacture. He considers that unless the Government made herd-testing compulsory it would never be carried out in Fiji.

Mr. Stuchbery said that he considered the use of concentrated foods as a matter of importance in Fiji because our only fodder plants were very bulky foods and the cattle did not always get the amount of nutriment that they could assimilate in the production of their butter fat. He men-

tioned that although they had experienced a dry season on the Western side of Vitilevu the Colonial Sugar Refining Company had maintained their production of butter fat by the use of cotton seed. The Colonial Sugar Refining Company were carrying out experiments with top dressing and he was much impressed with their efforts.

Convention adjourned until 9.30 a.m. on Wednesday, 8th October.

Thursday, 9th October.

Mr. Barnes in reopening the Convention said that he would summarise some of the more important points that had been brought forward. The first of these was the manufacture of ghee and he intimated that work was proceeding by the Agricultural Department to ascertain whether it would be possible to manufacture this product locally. With regard to the use of concentrated foods he said that it was well recognised that fodder grasses could well be supplemented by the use of concentrated foods such as coconut meal, ground nut meal, rice bran and cotton seed. Experiments in connection with fodder grasses took a long time to achieve results which could be recommended for general practice. He drew attention to an Article in *Agricultural Journal* No. 2 of 1930 dealing with the use of manures for keeping pastures in a constant state of fertility. He remarked that the Government were fully alive to the desirability of placing the dairying industry upon a sound footing and with this object had increased the subsidies payable on imported pedigree stock, grade cows and heifers. It was also proposed to introduce a subsidy on export butter.

Mr. Speight moved Motion No. 2 reading as follows:—

That this Convention appreciates the assistance afforded by Government to the dairying industry of the Colony by the increase and extension of the system of subsidies on pedigree and grade stock and welcomes the proposal to pay a subsidy on butter exported from the Colony.

The above motion was seconded by *Mr. A. H. Witherow*.

Mr. Duncan said that he was unable to support the final clause of Motion No. 2 regarding the subsidy on exported butter. The dairying industry had been going for 10 years and in addition to the direct subsidy had had 4d. per lb in its favour since it started. He proposed that the last clause be eliminated.

Major Willoughby Tottenham in seconding the amendment said that the butter industry was likely to become "an old man of the sea" and the industry would never grow up and stand on its own merits if it was pampered too much.

Mr. McElwaine said that the high cost of manufacture was due to the small output. The present cost of manufacturing 1 lb of butter and placing it on the market was 7.25d. per lb while the average cost in New Zealand was 2.5d. per lb for a factory manufacturing somewhere in the neighbourhood of 200 tons. The industry in New Zealand and Australia had been established for 70 or 80 years.

Mr. Barnes said that New Zealand had been cited on several occasions and it was interesting to note that in 1880 the value of export of butter from New Zealand was £8,350 and that time one might say that New Zealand was in a similar position to Fiji to-day. In the 10 years following the annual export increased to £122,700. The value of butter exported from New Zealand increased rapidly and in 1928 reached £11,960,000. He mentioned points to indicate that an industry of this nature invariably

had a small beginning and that the object of the original proposal was to arrange for the payment of some form of subsidy to assist the industry to get on its feet. He suggested that the final phrase of Motion No. 2 be amended by the insertion of the word "welcomes."

Sir Maynard Hedstrom said that he did not think it would be possible to find a common ground and that the Motion should be forwarded as an expression of opinion of the dairymen of the Colony.

Mr. Barnes said he proposed to do this and Motion No. 2 was therefore withdrawn.

Major Joske read *Mr. E. Duncan's* address on the copra industry as follows:—

I have been asked by the Director of Agriculture to give you an address on the copra industry of Fiji. I fear that the subject is too big for me to do full justice to in the time at my disposal, and I shall therefore merely confine myself to an outline sketch of the industry.

The Fiji Blue Book for 1929 gives the area of nuts in the Colony as 113,564 acres and the export of copra as 28,391 tons. I am under the impression however that the export of copra last year exceeded 33,000 tons, and believe that the area of coconuts in the Colony to-day has reached 150,000 acres. Relative to the area in the Colony which has been reclaimed from jungle, that of coconuts exceeds by far the area of all other cultivated crops combined; and I believe its importance to the Colony generally but especially to the native Fijian, is in direct proportion to its area, though its monetary value does not to my mind place it second in the list of crops, as shown by the mere statistics of the Blue Book. Sugar for instance is grown and concentrated compulsorily in only five districts in the Colony and at most covers 75,000 acres. (Blue Book figures give the area of sugar as 37,000 acres but this is wrong, apparently the areas of sugar land under young plant cane for the following year and in green manure crops having been omitted). Coconuts on the other hand cover 150,000 acres and the location of this growth extends to every inhabited island of the Fiji Group, hence my contention that the copra industry is by far the most important of any in the Colony.

Unfortunately, from various causes and reasons, copra production at the moment is not a paying proposition. Sugar, despite a protective tariff or bounty, at the expense of the consumers in Britain and Canada and to the extent of 50 per cent. of to-day's open market values, as also rubber, are both however in the same unenviable category if that is any consolation. Since restriction of production is out of the question and since we must continue to produce or go under, we must reduce the cost of production if we are to keep our heads above water in the flood of competition which surrounds us. Taxation in steadily increasing ratio to the value of our products cannot be imposed, as it has been for the past 20 years in Fiji, without increasing the costs of living in the first instance, and in the next instance, forcing an accompanying higher all round wages cost of production, and this precisely is what has happened in Fiji in the copra industry, as I shall show later in this paper. Not so long ago the annual budget of Fiji was £450,000 per annum and the population was 150,000, whilst to-day the figures are £650,000 and 165,000 of a population, showing an increase of approximately 50 per cent. in taxation and 10 per cent. in population.

It is in my opinion from these happenings that we are chiefly suffering to-day in our inability to produce profitably in competition in the open markets of the world. We have got "out of step" with costs in most

British Crown Colonies, but especially with those of the Dutch and Philippine Islands producers and are consequently being "trod upon." The actual coloured labour wages cost of producing a ton of copra in Fiji to-day is in the vicinity of £5, as against £2 10s. of 10 or 12 years ago, while to land a ton of copra in Suva, including wages as above, sacks, freights and insurances, European supervision and essential plantation supplies costs approximately £11, as against £7 as recently as about 10 years since. It would be futile besides being undesirable in my opinion had I failed to allude to or attempted to disguise these facts.

Improved methods of production, especially in curing our product by means of economic kiln drying and processing, hold some, though I fear at the moment rather remote, promise of better profits; but unfortunately most improvements cost money and money is a very scarce commodity with copra producers in Fiji to-day. Copra grading and the production of high class copra also come within the category of improvements that can be made in the copra industry of to-day, fortunately at small cost. When starting grading, which must be done under Government auspices and be made compulsory and applicable to all copra shipped from the Colony, difficulties and opposition may be experienced, yet I believe that its value would soon be demonstrated and ultimately grading would be welcomed by all classes of producers of and traders in copra in Fiji.

I do not purpose to go into details on the wages, tasks and such like of our labourers, but may say here that all planters fervently hope that in the revision of the Fiji Labour Laws, which it is generally understood the Government are contemplating, neither the obligations of the planters will be made more onerous or costly nor the liabilities of the employees lessened in any way, than in the existing Ordinances, and that contract or task work will be permitted and governed as at present with clear understanding that "no work, no pay" shall be the rule. Planters feel too that, if they provide food, housing and hospital amenities, they should no longer be called upon to furnish tobacco and clothing or prepay any Government taxes which may be imposed on workers engaged by them.

In conclusion some data may be given which may interest coconut growers: for ordinary trees the spacing should be not less than 30 feet by 30 feet in wet or 28 feet by 28 feet in dry districts. The yield over an estate of several hundred acres fronting the sea and running inland, say, one mile varies between 6 and 7 cwt. dry copra per acre per annum. On any such estate 5,800 to 6,300 nuts make one ton of copra. Usually 52 per cent. dry is obtained from green copra. The cost of producing and landing in Suva of one ton of copra, always provided the coconut areas are kept weeded and decently clean, is not less than £10 per ton, exclusive of interest on capital invested. Coconuts on Taveuni bear well up to 80 years of age, though their maximum yield is probably obtained when they are 20 to 50 years old.

Finally, as to the actual value or cost of the 150,000 acres of coconuts in the Colony to-day, this cannot be set down at less than three millions sterling. That of sugar on the other hand, stands at about one and three-quarter millions sterling, to which it has been written down from possibly three millions sterling several years ago. Then too there are many hundreds of thousands of acres of potential coconut lands scattered throughout the Colony still unplanted, whereas no sufficiently large areas yet remain in the dry districts to which successful sugar production is confined, for the establishment of more than one or two sugar mills. I estimate that at least there are half a million acres of unplanted coconut lands in the Colony, all of which could be brought into cultivation by the natives, or by European planters

if the wages and other costs of production were on a parity with those of our chief competitors.

Major Joske said that they had listened with great interest to the paper presented by Mr. Duncan, since he was not only the owner of one of the half-dozen biggest estates but also one of the Managing Trustees of the group of estates with the largest production in Fiji. Mr. Duncan's reference to the necessity of reducing costs of production justified the speaker in putting before the Convention three suggestions in this direction which would, he hoped, serve as targets for criticism from those present

Major Joske said:—In his address Mr. Duncan has brought his copra from its plantations to its port of export from the Colony. As we are now in Suva, let us imagine it arrived alongside Suva wharf. It is now on its journey to the crusher, and it is the costs incurred on that journey which are of vital interest to the producer in Fiji. I suggest therefore we might examine those costs for a minute. They are—

1. the labour costs involved in taking the copra from the side of the interinsular vessel, weighing it, putting it on a lorry and running it a few yards to a copra store, and finally stacking and storing it;
2. the cost of storing it, *i.e.*, interest paid to the bankers whilst the copra remains idle in Suva, and insurance against the risk of loss by fire, and the shrinkage and depreciation of the copra itself;
3. the labour costs involved in stacking and weighing the copra, carting it across the road and delivering it to the ship's side.

I suggest that it is in (1) and (3) that copra passing through the port of Suva meets with costs that could be eliminated. Mr. Duncan said that we have got out of step with costs in most British Colonies. Plantation labour costs are higher. Therefore, we must make every effort to reduce all other costs to the bare minimum. There is a way in which the Fiji Government can be of practical benefit to the coconut planters and also benefit the other sections of the community. That is by improving the wharf facilities at Suva. Suggestions have been put forward from the Suva Chamber of Commerce; the matter was raised a year ago in the Legislative Council; but so far we have not heard of any progress having been made.

My own view is that the following improvements to the facilities for dealing with copra at Suva should be made as soon as possible—

- (a) the strengthening of the wharf structure, so that motor lorries can load and discharge copra underneath the steamers' slings;
- (b) the provision of a waiting shed for copra;
- (c) a Government weigh-bridge.

As to (a), at present lorries are not permitted on the wooden structure of the wharf, which is too weak to bear them. This is indeed a lamentable state of affairs at the prime port of the Colony, and I venture to say there are very few ports in the world which would confess that their main wharf was too weak to stand an ordinary motor lorry. To take an example, at present copra ex "Makatea" in Suva is man-handled four times inwards and five times outwards. If motor lorries could come alongside steamers, it would be practicable to instal a weigh-bridge and the nine man-handling operations of copra could be cut down to four.

As far as (b) is concerned, as is well known there are frequent occasions upon which it is impossible for exporters to obtain export storage, on account of inward merchandise. The need for extra storage has already been recognised, but I would urge the extension of the present so-called storage facilities.

There is a space lying idle on that part of the wharf between No. 3 shed and the Harbourmaster's office, and I would very much like to see a shelter shed erected thereon in which storage for up to one week would be afforded to exporters. After all, copra pays an export wharfage of 6d. per ton. The cost of this shed need not be very great, practically a roof set on concrete pillars with weather protection at the side.

As to (c), I have suggested a Government weigh-bridge because weights taken under Government supervision would be probably more acceptable to the producer, the exporter and the prospective purchaser overseas. I suggest it really from policy reasons, but I would add that under present conditions, private enterprise would be prepared to instal a weighbridge if Government decided such a thing was to be left for private enterprise. In such a case of course one would not expect Government to reverse its decision and subsequently instal a weigh-bridge in competition. I have sketched the above in outline as this is not the place in which to go into the matter in detail. I put it forward as a practicable suggestion for reducing the costs of the operation of moving the copra from the planter to the crusher.

My second suggestion is to do with the overhead costs of the coconut industry. One of the most important of these costs is that of borrowing the moneys necessary for development. The planters' capital is restricted and the occasional advent of a hurricane depletes the larder. Now that the Colony has a better supply of labour one of the obstacles to the development of coconut areas has been removed. I suggest that the Government should help on this development, and thereby follow the example of many other countries— by making available loans to coconut planters at low rates of interest, repayable over a long term of years. At present the coconut planter would have to pay $7\frac{1}{2}$ per cent. interest to his banker plus probably $\frac{1}{2}$ to 1 per cent. to his guarantor if he desired advances. I suggest that Government might make advances to approved settlers at bare cost, say, 5 per cent. plus the necessary provision for sinking fund, and amortization. The business could quite easily be handled by a Coconut Advances Board of Control on very much the same lines as for example, the Returned Soldiers and Sailors Advances Board. Personally, if I were choosing a Board to-day I should say that a Board composed of the Colonial Secretary as Chairman, the Colonial Treasurer, the Director of Agriculture, Sir Maynard Hedstrom and Mr. Duncan would be hard to better. It may be argued that this time of depression in the price of copra is the wrong time to consider such a proposal; quite the reverse, as it is in times such as these that the planter needs financial assistance in the greatest possible degree.

My suggestion is intended to apply not only to development but to existing mortgages. The price of copra was not always going to remain where it was to-day. I hope although I would not bet on it—to see it back to worth round about £15 a ton at the plantation in perhaps twelve to eighteen months.

I now come to the third suggestion which is one for improving the price obtained for the planter's copra. We had the pleasure of seeing yesterday* a very interesting exhibit put up by the Coconut Committee, and the difference between ordinary native sundried copra and copra which had received some reasonable attention was most marked. I think there can be no doubt that good quality is worth more than inferior, or even medium, and this is probably more especially the case under present circumstances where more and more of our copra is finding its way to the United States. That being the case, we should encourage the United States to look to Fiji

* At the Fiji Show.

for their supplies of good quality copra. There can be no doubt that we have got the goods, but on the other hand, we are not making the most of them. My third suggestion therefore is the separation of good copra from bad copra, and the issue of Government certificates on which the buyer can place the utmost reliance. At present the crusher buys 100 tons f.m.s. copra from Fiji. He may have the luck to have included in the consignment some of the nice white copra we saw on Monday. On the other hand, he may get a dirty weevily article. Being a prudent man, he therefore insures against this possibility in the price, which he pays for his parcel of copra. In other words the good copra is damned for its association with the bad. One might also quote Gresham's Law—that a bad coinage drives out the good.

This matter has been before the Legislative Council as far back as 1927, and a scheme was drawn up which provided for compulsory grading of copra intended to be exported. When the Bill came before the Council it was varied by the substitution of voluntary grading for compulsory grading, and became a dead letter. The view of the Directors of the Coconut Planters' Union is that to succeed at all, grading must be applied to all copra leaving Fiji. We feel too that if Fiji leads the way in establishing certain standards, it may be possible before long to obtain the co-operation of Tonga and Samoa in establishing similar standards. The buyer of copra in San Francisco or in London will then know what he is getting, and it will serve to eliminate the present gamble against securing a good, bad or indifferent delivery against his purchase of South Sea copra.

Everyone will be unanimous on the question of the difference in the quality of plantation copra and ordinary native dried copra, the logical thing would therefore seem to separate these grades. The objections are:—Firstly, the cost of such grading and, secondly, that no increase in price will thereby be received. As I am representing the Union established at Suva, it is only proper that I should view the question of costs at Suva alone. Earlier in this paper, I made suggestions for cheapening the handling of copra at Suva, and one of these suggestions involved the erection of a waiting shed for copra. I would propose that this shed should be utilised for the reception of copra at Suva, and that the grading should take place in that shed, or in licensed warehouses owned by responsible exporters, by some suitable officer of the Agricultural Department. An appropriate export mark should be allotted and the copra marked accordingly. The additional cost will therefore be very small, probably only a matter of a few pence per ton, and I submit that the increased revenue to those who sink money, time and care in improving their product will more than justify the results.

As to the second objection that the results will not be commensurate, I imagine this has been an objection to grading of produce ever since the word was first known. Its truth or otherwise in the case of copra can only be proved by experiment over a period of years and since the method I have outlined is one involving no capital outlay, which will not be of great advantage in other ways, I suggest that the objection should not prevent the adoption, at any rate experimentally, of compulsory grading for export.

In summing up the three suggestions I have put before you perhaps I may call them Faith, Hope and Charity. May I say that Faith stands for copra grading and the consequent faith of the crusher of copra in the quality of Fiji copra; Hope for the hope that the Government will improve handling facilities at Suva; and Charity, which begins at home, for the extension of cheap loans to poor planters in these hard times.

Sir Maynard Hedstrom in opening the discussion on this paper said he had been asked many times his opinion as to the reason for the long and continued slump in price of copra. From what Mr. Duncan had said one might gain the impression that the price of copra was influenced largely by the quantity produced but he did not think that that was a factor because the increase in the production of copra had been comparatively small. In 1919 the world's crop was estimated at 785,000 tons and in 1927, 1,135,000 tons. He considered that the factor controlling the price of copra was the production of thousands of tons of Soya bean and ground nuts. In 1920, the production of Soya bean was 719,000 tons and in 1927, 1,958,000 tons. Another factor of importance during the last few years was the production of whale oil. Eight years ago this was 450,000 barrels and in 1928 the production increased to 1,500,000 barrels, while the production for 1929 was estimated at 2,000,000 barrels. The copra producer had his whole investment in his plantation and could not stop making copra just because the price was low, while the growers of linseed, Soya bean or ground nuts could turn their hand to something else if the price was not profitable. *Sir Maynard* went on to say that with regard to the grading of copra he did not think that any good could be achieved by compulsory Government grading.

Mr. Taylor outlined the position with regard to the control of coconut pests, namely Levuana, Scale and Spathe borer. He said that the work on the first two pests had been brought to a successful issue and the borer work was promising.

Mr. Surridge suggested that instead of the square system of planting the equilateral triangular system should be adopted since this adds about 10 per cent. more trees to the acre without any disadvantage. With regard to the question of grading it had been found essential to adopt compulsory grading methods with most agricultural produce, for example, coffee, maize, cocoa, butter and fruit. It was reasonable to assume therefore that methods which have improved the quality and price of such produce should tend to have the same result when applied to copra. *Mr. Surridge* referred to the rat as a pest of coconuts. He stated that the average damage by this pest to coconut plantations was probably 5 per cent. for the whole of the Colony while on individual plantations it had been estimated after investigation at about 12½ per cent. This was a matter that required urgent attention.

Mr. Barnes said that the address and discussion could not but be interesting to any person whether he was directly concerned in the production of copra or not. One of the most important points raised was the general activity directed to the reduction of rats. He said that extermination was perhaps something too much to be hoped for but there was need for active measures on the part of all people in the Colony to suppress these rodents which caused damage amounting to hundreds of thousands of pounds per annum. He said that he was strongly in favour of improving the wharf facilities at Suva which would have for their object a reduction in the costs between the producer and the crusher. With regard to grading of copra *Mr. Barnes* said that perhaps instead of a system of grading, the producer might be encouraged to turn out a higher quality of product and to endeavour to get more from the same amount of raw material. In an article in the *Agricultural Journal* by the Government Chemist it was shown that 12 per cent. of the copra is lost through insects and mould. This represented almost one eighth of the copra exported and meant a loss of £1 per ton on the present day price at the plantation.

Major Willoughby Tottenham moved Motion No. 3 as follows:—

That in the opinion of this Convention the position of the copra industry gives cause for disquietude and that the possibilities of

securing increased returns to producers should be explored such as by increase of yield, the reduction of production and transport costs and the introduction of a system of Government grading.

Major Willoughby Tottenham in speaking to this motion said that the noxious weed problem was serious. The keeping of these weeds down added considerably to the cost of producing copra. He said that *Major Joske* had urged the provision of more shed accommodation at Suva but he considered that wharf and shed accommodation should be provided at other places in the Colony, for instance at Buca Bay or Taveuni where the copra was produced. If this were done costs would be reduced about 12s. per ton.

Major Joske seconded Motion No. 3 which was carried.

THE BANANA EXPORT INDUSTRY.

After the luncheon adjournment Mr. Barnes reopened the Convention and addressed the meeting on the banana export industry, which he said was of considerable importance to Fiji, but had unfortunately deteriorated during the past few years mainly owing to the incidence of disease and the irregular and improper methods or lack of methods practised by the Fijian cultivators. The industry had been adversely affected by the hurricane of December, 1929. He remarked that minor amendments had been made to the Regulations and the most important of these was the appointment by the Governor of a Banana Licensing Board which would have power to fix the minimum price to be paid for bananas at packing stations. Indians were very anxious to obtain the same treatment as Fijians with regard to the purchase of bananas and this question was being considered by Government. Mr. Barnes went on to say that considerable uneasiness had been caused amongst banana buyers at the more strict interpretation of the Regulations governing the export of fruit from Suva. He said that reports had been received from merchants and Inspectors in Auckland indicating that there was considerable laxity through the whole industry at this end and that the growers were cutting fruit which was unsuitable for export. It was felt in the interests of the whole industry that that state of affairs should not be permitted to continue and instructions had been issued to the inspecting staff that a much stricter inspection of the fruit was to be made. He remarked that much still remained to be done in connection with the improvement of the general quality of the fruit offered at the packing stations and he felt that all those concerned in this important industry had a long way to go in the work of instructing the native and the Indian grower in the grades and quality of fruit suitable for export. The Department of Agriculture in conjunction with the Native Affairs Department were doing everything they possibly could to teach the Fijian grower. With regard to the packing Mr. Barnes said that he could not help but be struck by the general inferior quality of the cases which were used for Fijian bananas. He considered this one of the weak points of the banana industry to-day. He gave an instance of cases from Sweden and Norway being imported to South Africa at about 1s. 1½d. Another important matter affecting the banana industry was the question of transport. He had it on good authority that a large number of cases of bananas could be secured from the Savusavu district if only regular transport arrangements could be made to pick them up. Similarly he felt that there was every prospect of reviving the industry in the Sigatoka district if some regular system of transport could be evolved. He remarked that the banana industry in

normal years was worth £200,000 per annum to the Colony of Fiji and at the present time we had only one quarter of that. Mr. Barnes went on to say that recently trepidation had been felt because of the threatened competition from Samoa and Tonga. If Western Samoa could be sure of a regular steamship service with proper provision for fruit, Fiji could be almost entirely cut out of the New Zealand market. He thought that New Zealand preferred Fijian bananas but there was always the possibility that some arrangement might be made to extend the industry in Samoa and get those bananas from Samoa to New Zealand. He said it must be borne in mind that Samoa was a Dependency of New Zealand and though we had a better quality of fruit there was the danger of losing the whole market if we did not improve and keep on improving our standards.

Mr. Witherow said that the position of the banana export industry was very poor compared with what it was when the Australian market was open to Fiji. The high rate of freight was a hindrance to the industry. In 1916 the Union Company notified the shippers that it would be necessary to raise the freight from 1s. 9d. to 2s. per case. From then onwards there had been a gradual rise until now the freight is 4s. per case—more than double what it was in 1916. Mr. Witherow intimated that he still considered there were prospects of profitably shipping to Australia.

Mr. N. MacDonald said that a subject of this nature could be classified under three headings, shippers, buyers and native growers. He remarked that he did not think some buyers took sufficient interest in the areas allotted to them. He considered that every endeavour should be made to establish demonstration plots in each district where methods of cultivation, selection of plants, and proper planting could be shown. The natives should be instructed in the use of implements.

Mr. Windham said that he had been investigating diseases which were causing havoc to the industry. He said the plantations in Fiji were very scattered and this made the work very difficult.

Mr. J. L. Hunt said that the present rate of export was about 7,000 cases a month. One person with 1,000 acres of land would be able to export 15,000 cases per month and it would not be as expensive as now. He said he was very pleased to see that the Government had taken in hand the investigation of the diseases of bananas. Little work of this description had been done of recent years.

CONTROL OF NOXIOUS WEEDS IN FIJI.

Mr. Barnes presented a paper on "The Control of Noxious Weeds in Fiji" (*vide Agricultural Journal* No. 3 of 1930).

Mr. J. L. Hunt in opening the discussion on The Control of Noxious Weeds in Fiji said that in 1889 there were practically no noxious weeds in Fiji. Now the people of the Colony were right up against things with animal life carrying the seeds of noxious weeds and so increasing their spread. The expense of clearing was very heavy, ranging from £3 to £5 10s. per acre. He was pleased that the Entomologists of the Agricultural Department had been able to introduce the Thrips to assist in the control of Koster's Curse and he considered that the people of the Colony would have to look to the Entomologists of the Agricultural Department to help them in the eradication of other noxious weeds.

Mr. T. H. C. Taylor said that the control of noxious weeds by means of insects was one of extreme difficulty and that people expected rather too much in that direction. Although work had been going on for many years on the subject of the prickly pear in Australia it was only lately that

any marked progress had been shown. He said that he wanted to emphasise that the greatest care must be taken in introducing insects to control weeds. For instance there were at least twenty different species known to exercise a control on "Koster's Curse" but a lot of investigation was necessary to decide whether or not some of these insects would attack crops of economic importance in the Colony. He thought that it was likely that the biological control of "Koster's Curse" would be a long work and that other insects would have to be imported. He informed the Convention that in the case of Lantana considerable success had been achieved in certain districts, but he must again state that the biological control of noxious weeds was only in the experimental stage and people must not expect rapid results.

Mr. Barnes said that efforts had been made to introduce a parasite for Guava and although inquiries had been made in various parts of the world no success had been attained. He said that experiments were being carried out by the Department of Agriculture in the use of various types of sprays including sodium chlorate.

Mr. E. Duncan in moving Motion No. 4 as follows:—

That in the opinion of this Convention a more active campaign directed to the control of noxious weeds in Fiji should be pursued. said that he hoped eventually we should be successful in controlling "Koster's Curse." He instanced that on Taveuni every ton of copra produced cost 30s. for weeding.

Mr. A. H. Witherow seconded the motion, which was carried.

Mr. Barnes said that there was one other subject for discussion, the production and marketing of minor crops and this would be considered at a later date.

Mr. Barnes in declaring the Conference closed said that His Excellency had informed him that the Convention could be assured of His Excellency's full sympathy and he hoped the deliberations of the Convention would benefit the Colony. *Mr. Barnes* said he would like to make a few remarks in connection with the Convention of Associations which was the subject of Motion No. 1. That expression of opinion was backed up by the representatives of the various Agricultural and allied Associations of the Colony and was one that would ultimately be given effect to. It would be necessary to draw up and consider rules and regulations for such a Convention. He considered that each Association should be permitted to nominate a certain number of members to serve on the Convention, the number to be decided by a Committee which would sit to consider this matter. He said the Convention would also encourage and assist the formation of District Agricultural Associations and would permit representation on the main body on terms to be decided upon. He saw no objection to the utilisation of the *Agricultural Journal* as the medium of publication for Convention matters. He suggested that the Committee already appointed should be authorised by the meeting to continue its work and to co-operate with representatives from other associations in Fiji to devise Regulations and to form a Convention of Associations. Speaking on the the other subjects raised during the discussion *Mr. Barnes* said that quite a lot of important matter had been dealt with. With regard to the Dairying Industry it was a matter of great pleasure to him to hear a discussion on a wider basis than on the occasion of the January Conference. Referring to the Copra Industry he said that the Convention had been able to follow the coconut from the tree to the market and to find out where best it could be helped. He said the Banana Export Industry had come in for its fair share of consideration and certain proposals put before the Convention would receive attention.

The subject of control of noxious weeds was one that was of very wide interest. During his experience in Fiji and from remarks of those he had met, Mr. Barnes said he could well believe what a menace the problem is to agricultural industries and it was the duty of the community to see that the menace was attacked in no uncertain manner. He said the thanks of the Convention were due to the Committee which sat to organise the first meeting. Thanks were also due to the Trustees of the Fiji Museum for placing the room at the disposal of the Convention for the purpose of holding the meeting. In conclusion Mr. Barnes thanked all who had attended and had contributed by reading papers and taking part in the discussions.

Mr. J. L. Hunt proposed a vote of thanks to the Chairman which was carried by acclamation.

Mr. Barnes then declared the Convention closed.

Saturday, 12th October, 1930.

Mr. Barnes in opening the discussion on the Production and Marketing of Minor Crops said that the definition of minor crops was a fairly wide one and for the purpose of the discussion could be taken to include all crops apart from sugar, coconuts and bananas, and of course, dairy products. He remarked that there were undoubtedly a large number of crops grown in small areas in different districts either in conjunction with major crops or else as separate little agricultural industries. Some of these found their way by devious channels to the local markets in Suva and other parts of the Colony, but there was no organised system either of production or marketing. He said that he had received inquiries from Sydney in particular and from other places for some of these minor crops which could be grown satisfactorily here in sufficient quantity and of sufficiently high quality to command good prices in overseas markets. He remarked that he had been informed by one distributing firm in Sydney that there was an excellent opportunity during June–August to place French Beans on the Sydney market and it was reasonable to expect that one could obtain a price for a properly graded product equivalent to 12s. to 20s. per bushel case. There was also a good demand for the seed in Queensland and New South Wales and he was led to believe that the value of the seed was from 45s. to 60s. per bushel. *Mr. Barnes* then instanced the water melon which grew well in Fiji and for which a ready market existed in Sydney. Small farmers should be encouraged to grow these minor crops provided that some satisfactory organisation existed for marketing them. He went on to say that that point was one of the most important in the agricultural development of the Colony and with that object in view His Excellency had appointed a Committee to consider the agricultural methods of Fijians and Indians. *Mr. Barnes* read a letter received from Messrs. A. Q. McGowan regarding minor crops and said that this indicated that ready markets existed for a wide range of products which grew well and produced heavily in Fiji but that apparently growers were not prepared to accept world market prices for their produce. He said that this opened up the question of the need for a sound agricultural educational programme directed not only to the education of the children in the school but to the producers on the land.

LETTER FROM A. Q. MCGOWAN AND CO.

Dear Sir,

Suva, 10th October, 1930.

We have pleasure in handing you the following information relative to experiments and possibilities of business conducted by us covering products which we consider would be profitable to small farmers here.

Kumalas, (Canadian Market).—A trial shipment of mixed red and white kumalas to Vancouver were disposed of to Canadian Pacific Mail Steamers realising 18s. per cwt. They were not landed or sold to merchants there for the reason that only white kumalas were in demand. We have not been able to interest any local growers in the export of white kumalas to Canada. A large market is open to us for these during the winter months only—December to April.

Maize.—Trial shipment to Vancouver of good quality clean, new maize received favourable comment, and resulted in many inquiries and orders for parcels of 50 tons and up to 200 tons per month. However, the local price was not in keeping with the world's ruling market, which at that time was £9 per ton c.i.g. or about 4s. 6d. per bushel c.i.f. We endeavoured to get maize production going on a large scale, but no grower was interested. We have not since been able to induce any Indian or European to grow maize for export.

Peanuts.—Growers in Fiji will not accept the world's market for export and refuse to produce except for local requirements, and at a price to suit their own ideas. We have tried out the possibilities in shelled Fiji peanuts on the New Zealand market, however, we had to meet the Java competition which would not allow us to do business at present values. Fiji shelled small peanuts are worth about £20 per ton c.i.f. Auckland. Java large shelled nuts are worth to-day £25 per ton c.i.f. No large peanuts are at present produced here, the growers stating that they present a little difficulty in harvesting as against the easier grown small nuts. Fiji shelled peanuts are declared to be far sweeter and firmer than the Java varieties sold. Price is the factor. We cannot compete.

Blackeye Beans.—These can be produced here cheaply and at competitive prices for export. The difficulty is, however, to supply a clean sample free from weevil. We have not yet secured a clean, dry sample grown by Indians, and have therefore given up the experiment.

Cow Peas.—Each year we receive numerous inquiries for quantities, however, the same remarks apply as to Blackeye Beans.

Rice Beans.—We also receive inquiries for large quantities, but the same remarks apply.

Ginger.—We have successfully established an export market for green ginger during the months of January to June only, and will be exporting during the coming season. Growers receive £18 per ton delivered to our store for prime, clean, well-grown samples only. No inferior quality is exported on any account. We have a big outlet for cargo ginger packed in light syrup in barrels. But this business cannot be tackled until the production reaches some volume. This is worth to-day £60 per ton c.i.f. We are hoping to establish business in cargo ginger within the next 18 months, provided the growers will increase their production sufficiently.

Pepper.—We have received inquiries for this but there is no production in Fiji. All our requirements are imported from Singapore, and costing to-day £168 per ton. This is also largely consumed by the Indian population.

Coriander Seed.—This does well in Fiji, but growers demand a higher price than the landed cost of imported seed. So that no export business is possible at present. This is worth to-day £15 per ton c.i.f. London for prime quality, market fluctuates violently depending on crops in India and Morocco.

Pimento.—A trial shipment to Melbourne realised £28 per ton five years ago, since then the market has been as high as £140 c.i.f. London, and now is £80. We have also tried to interest both Indian and European farmers in pimento, but without result.

Turmeric.—Excellent wild turmeric is produced here but is marketed in such poor condition, and so badly prepared, that only small quantities are used. We have asked Fijians and Indians to prepare it properly but they say it means so much extra work for them. Our efforts have been fruitless. Imported turmeric is worth to-day £28 per ton c.i.f. London for best quality.

We shall be pleased to give you any further information relative to above products should you desire it.

Yours faithfully,

A. Q. MCGOWAN,
The Director of Agriculture, Suva. for A. Q. McGowan & Co.

Mr. Pearson said that he would limit his remarks to the question of minor and side line crops for small Indian farmers outside the sugar and plantation areas, produced either for domestic consumption or for sale. It appeared to him that there was a certain lack of enterprise and a good deal of improvident farming going on. In the drier districts of the Colony rice should be considered as the major crop for the Indian although in some districts this was being replaced by cotton. He said that with cotton and rice growers a certain amount of under employment was inevitable unless they had something else to fall back on. Dhal was important as dhal or a pulse of some sort was necessary to the diet of a rice eating people. Two varieties were grown but production was not altogether satisfactory and the crop was subject to the ravages of insect pests. He went on to say that next in importance was maize grown both for supply to the Colonial Sugar Refining Company and very commonly in small patches for home consumption. This crop would be much more widely grown if a ready market could be found for it. He understood that experiments were in hand for the manufacture of maize flour which would certainly be in demand among certain classes of Indians. He also considered that some of the quick growing Indian barleys might succeed well in the Colony and also contribute to the reduction of imported flour and sharps. Other minor crops not to be lost sight of were tobacco, potatoes, ground-nuts, Mauritius beans, and in some areas eating pines. Bananas must be looked on at present as a minor crop from the Indian point of view. Then again there were condiment crops such as coriander, turmeric and mustard and it seemed not impossible that one or two of these condiment crops might be developed into quite an important commercial product, even for export purposes. Mustard oil was another necessity of Indian diet and here again the imported article which was inferior in quality could be replaced. *Mr. Pearson* went on to say that market gardening was another avenue of activity for the Indians of the Colony. The Indians in Fiji seem to have forgotten what is done by their fellows as market gardeners around the big cities of Northern India. It had been proved by the success of the operations of the Agricultural Department in various Provinces of India that progress was possible. He said that the antiquated idea that if you wanted to grow a crop you had only to procure the seed and put it in without regard to variety or local conditions must be abandoned. He considered that a produce market for Suva was very essential as otherwise the Indian had to hawk his produce around from door to door. An important aspect of the marketing question was the matter of communication and getting the produce to the markets.

Mr. Grant said he would like to say a few words about ghee. Even that morning he had tried to buy a bottle of ghee and was willing to pay 3s. to 4s. a bottle for it, but was unable to procure any. The ghee imported

into Suva was of very poor quality. He went on to say that mustard seed grows very well in Fiji and instanced one Indian planter who planted up one acre and sold six or seven bags of seed from that area to the Colonial Sugar Refining Company at £2 a bag. He considered that if Fiji could standardise a ghee mixture suitable to the local market there would be a considerable source of income to the producers. Potatoes were imported in large quantities and yet they could be grown very successfully in the Nadroga district. He said there was also the question of sending round men trained in agriculture to teach the Indians how to plant. He was trying to form an Indian Agricultural Association of Planters so that they would be able to co-operate with the other Associations in promoting the welfare of the Colony.

Mr. Buksh mentioned peanuts and Beni seed, because they were important so far as the Indians were concerned. Another crop of importance was tapioca. It was one of the staple foods of the Fijians and the Indians were also taking to it. With regard to rice he considered that the varieties we were using in Fiji had become deteriorated owing to the mixture of seeds and he thought this matter should be considered. In India they had two seasons for rice.

Mr. Fountain said that he had been living in an Indian district for the last eight months and they were all complaining bitterly about the failure of the rice crop and seemed very keen to grow ginger. He said that he would like some information about coffee as he considered that as a side line crop in Fiji this was an excellent proposition.

Mr. A. L. Armstrong said that the Government was very fully alive to the necessity of encouraging the production of crops by Fijians particularly of supplementary crops to those now grown. He said the first thing to do was to educate the Fijians in modern methods of agriculture and the use of implements. He informed the meeting that one Agricultural Instructor was now working in the Sigatoka district, giving practical instruction in the handling of a plough and harrow. This Instructor also assisted the various villages in the marketing of their crops. *Mr. Armstrong* stated that it was essential to have an assured market for any crops Fijians grew otherwise they became discouraged and it was difficult to interest him in anything further.

Mr. Surridge said there were two aspects of minor crops he would like to draw attention to. The first was seed selection and he referred to the specimens of maize exhibited in the Agricultural section of the Show, one specimen grown by Fijians and Indians and the other grown by an European, where the contrast in the quality of that grown by the European was very striking. The other question he continued was one of cultivation. Referring to market gardens worked by Chinese he said it was usual to see the soil cultivated to a depth of 4 inch to 10 inch, whereas in the garden of an European householder one would find the soil cultivated to a depth of 16 in. He remarked that the additional 6 inch or so was very valuable for supplying food to the plant.

Mr. Barnes said that the mass of information supplied by the various speakers would be very helpful in assisting and encouraging the agricultural development of the Colony. In closing the discussion he called attention to a few points. With regard to Beni seed or Sim-sim he said that this was grown in large quantities in East Africa and also in West Africa. It should do well in the dry districts of this Colony, and find a ready local market. It was a crop worth while encouraging because it would fit in a system of rotation. He said that he would have liked to have seen a

representative of the local oil mill present at the meeting as one of the officers of the Department had discussed with the Manager of the Oil Mill the question of extraction of vegetable oils. He emphasised the desirability of improved systems of cultivation. This subject was one which the Department of Agriculture and the Native and Indian Departments were very much alive to and steps were being taken to give effect to recommendations in regard to instruction in agricultural districts. In conclusion Mr. Barnes thanked those present for attending the meeting and for the interest they had taken in the subject.

LANTANA POISONING OF CATTLE IN FIJI.

By C. R. TURBET, B.V.Sc., Senior Veterinary Officer.

SINCE the first recorded case of the disease which we now know to be Lantana poisoning, the disease, in certain locations, and under certain conditions, had become increasingly more prevalent during the past few years, until the incidence of the disease assumed such alarming proportions that considerable consternation was felt among local cattle men. For a time it was thought by them that some new mysterious infectious disease had been introduced into the Colony with imported cattle. Suva butchers were suffering severely, losing a varying percentage of nearly every lot of cattle brought into Suva for slaughter. New animals brought into local dairies were liable to contract it, as were also those newly imported and animals recently brought into the Suva district for the hospital and other dairies and those in transit through Suva.

The disease did not closely simulate any known acute infectious disease. It showed some resemblance to poisoning caused by the ingestion of certain plants characterised by photo-sensitisation and more closely resembled the text-book description of *Lupinosis*.

Occurrence.—The disease occurs in the Suva and lower Rewa districts of Fiji and less commonly at Tailevu and Navua. It has not been recorded as occurring elsewhere but probably does so under certain conditions. The occurrence of the disease is limited to either young animals bred and reared in the beforementioned districts or animals of any age brought into them. In the former group it would appear that the calves recently weaned and beginning to sample new fodders are liable to contract the disease and slightly older animals tethered or confined within reach of Lantana and on a restricted diet of other vegetation. In the latter group a sequence of events seems to be necessary; subjection to hardship or change of habitat such as occurs when cattle are brought to Suva from some other place either within the Colony or from overseas. In the first case a journey by boat or punt or a long walk overland is necessary, in the second case a long overseas journey. It is assumed that these animals are in most instances, on arrival at Suva, suffering from partial starvation and in all cases have a lowered vitality.

In the Rewa occurring cases¹ the animals affected were heifers. One lot locally bred, nine months to a year old were depastured on the river bank, the other lot, imported heifers about 18 months old, were on an island. In each case Lantana was the chief vegetation. Other plants present were *Solanum torvum*, Guava, *Panicum barbinode*, *Mimosa pudica*, *Paspalum conjugatum*, a species of sedge, wild gooseberry, *Sida rhombifolia* and *Cassia obtusifolia*. The edible plants in each case were scantily present and non-edible plants predominated.

In the Tailevu occurring cases² the grazing area was suddenly restricted owing to a flood in the river. It is presumed that this caused the affected animals to sample unusual fodder plants.

Cause.—The Lantana plant in Fiji has always been considered to be *Lantana camara* and under that name the cause of the disease was cited in the first published paper³ by the writer on this subject.

Dr. Seddon, Director of the Veterinary Research Station, Glenfield, New South Wales, stated⁴ that his station had not been able to find any evidence of toxic properties in *Lantana camara*. He also mentioned that *Lantana crocea* is undoubtedly very toxic. This communication caused the writer to doubt the identification of the Lantana common in Fiji which had always been taken as fixed. On examination the characters usually ascribed to *L. crocea* were more pronounced than those ascribed to *L. camara* and therefore specimens of the plant were forwarded to Dr. Darnell Smith, Curator of the Botanical Gardens, Sydney, who named them *L. crocea*.

Description of the Plant.—Manson Bailey states⁵ that "*Lantana crocea* closely resembles *L. camara* but is much shorter and more compact, the heads of the flowers are also the same size and form, but the colours are apt to sport, some producing white, others blue, the normal colour being bright red orange and yellow towards the centre of the head." This description answers that of the Fiji species. It is a compact plant but in competition becomes taller with weaker branches. Along the stems a bronze colouration is noticed in some plants. The flower colours range as follows:—white, white with yellow centre, yellow, mauve in various shades, mauve with a yellow centre, red in various shades, red with yellow centre. No blue flowers have been seen by the writer in Fiji. It is possible that both *L. camara* and *L. crocea* occur in Fiji.

The Toxic Principle.—No work has yet been done on this subject by the writer and no reference to it can be found in literature. This remains the subject of further research.

History of the Disease in Fiji.—Although the knowledge of the cause of the disease was only definitely ascertained during 1928, the occurrence of the disease we now know to be Lantana poisoning was first recorded⁶ in Fiji in 1913. In June, 1913, Lawrence P. Edward, Government Veterinary Officer, reported on the death of a cow at the hospital as follows:—

"This cow was first noticed to be sick about a month previous. It was at once isolated and treated. When visited on June 23rd, she was obviously dying and so I destroyed her. When first noticed she had extensive ulceration of the muzzle and buccal mucous membrane and eyelids, with discharge from the eyes, nose and mouth. She was eating well and the temperature was 103°F. The cause is the necrosis bacillus. The symptoms gradually increased in severity with the addition of necrosis of the skin behind the ears and over the body. *Septicæmia* resulted and caused death. This condition is not very rare in Fiji. It is usually seen in recently imported animals and is very contagious and very fatal. The number of recoveries do not amount to more than three or four per cent."

Edward again reported⁶ on the death of a second cow during the same month as follows:—

"The cause of death was septicæmia resulting from extensive necrotic lesions on the mouth, on the muzzle, eyelids and skin caused by the necrosis bacillus. This was a similar case to the one reported earlier in the month. The rest of the cattle are perfectly healthy."

Again in December of the same year Edward reported⁶ on the death of a bull at the hospital dairy as follows:—

"I was called in to attend the bull on the 16th December. I found him to be very weak, staggering in his gait, temperature 104°F., constipated, loss of appetite and very emaciated. The integument over the muzzle was dry white and inclined to crack, there was profuse discharge from the eyes (which were very much drawn in) nose and mouth.

"The most noticeable symptom was the skin; this had lost its flexibility and had become hardened. (I can only liken it to "raw hide"). The hair in parts had fallen off. In those parts where there was much movement of the skin it had become folded and from the bottom of the folds a yellow serum was exuding. The bull died on the 19th and a post mortem was made.

"There was a gelatinous exudate under the skin. The liver was enlarged and fatty. The gall bladder was very much engorged and inflamed. It was rather larger than a human head. There was acute inflammation of the abomasum, large and small intestine.

"This is the third case of this kind that has occurred at the dairy. I am now of the opinion that it is caused by some poisonous weed."

Following Edward's report the Chief Medical Officer reported⁶ to the Government as follows:—

"It is with great regret that I have to report the death of the newly purchased bull at the hospital dairy. It was quite well on arrival and the Veterinary Surgeon reported well of it earlier in the year we lost two newly imported cows from apparently the same cause the Manager of the Brighton Dairy Company states that he has at times lost cows, especially newly imported ones from a similar cause."

There appears to have been no further record made of the occurrence of the disease from 1913 until the writer's arrival in Fiji in 1923. In that year the writer's attention was first drawn to it in the course of conversation with cattlemen. Later in that year the first cases were observed among some cattle at Waimanu. These cattle had just a week or two previously arrived in those paddocks. Since then the disease has been often observed by the writer and Veterinary Officers of the Department of Agriculture, the outbreaks occurring chiefly in the vicinity of Suva and on the lower Rewa. In 1924 in an endeavour to ascertain the cause of the disease bacteriological tests with material from an animal dead of the disease were made in co-operation with Mr. J. G. C. Campbell, B.Sc., Government Bacteriologist. The results of these tests⁷ were negative. Between that time and the end of 1927 feeding experiments were conducted with various plants including Lantana with negative results.⁷

On the 30th December, 1927, feeding experiments were commenced with *Lantana crocea* which ultimately led to the conviction of that plant as the cause of the disease.³

Since then, owing to the knowledge of the cause of the disease, cases have become fewer and the tendency to panic on the part of some stock owners has passed.

Symptoms.—In from two days to a fortnight after the animal has had access to lantana, the first symptoms are noticed. At first the animal manifests restlessness and loss of appetite. Soon constipation sets in and grinding of the teeth is heard. If the temperature is taken about this time it is found to be elevated to about 103°F. The skin of localized areas becomes very sensitive and later intensely inflamed. This is accompanied by an intense irritation which causes the animal to shake its head and rub its parts particularly the head and ears against fence posts and trees. A

mucoïd discharge from the nostrils and a lacrymal discharge from the eyes sets in early. There is also dripping of saliva from the mouth.

The parts chiefly affected are the skin of the muzzle and eyelids, the ears and the perineum, udder or scrotum. If the animal has unpigmented areas on the body, the disease will show a preference for these locations and the skin lesions are always more intense on animals with unpigmented areas. These animals, however, are by no means the only animals to be affected with the disease which has been noticed on animals wholly pigmented. In such animals the skin lesions are not so acute but the disease may be just as fatal, the sites invariably affected being the muzzle, the ears and in some cases the coronets and base of the horns.

The inflamed muzzle becomes covered with a brownish yellow serous exudate from the surface. A similar condition is noticed on various parts of the body and the hair becomes matted with dried serum. Two days after the exudation of serum the inflamed areas become devitalized, hard and yellowish-brown. The muzzle is covered by a dry smooth yellowish-brown scab which becomes necrotic and grey in areas where the nasal discharge flows over it. The eyes are sunken and a few days after the onset of the disease the conjunctival mucous membrane is distinctly icteric. The same condition is noticed in other mucous membranes. The discharge from the nostrils and eyes becomes muco-purulent. Abdominal pain is manifested generally by groaning, grinding of teeth and assuming unnatural attitudes. Skin irritation is shown by the animal endeavouring to gain relief by rubbing against solid bodies and one animal was noticed to screw its body in a peculiar manner as though shrinking from pain. Tenderness is particularly manifested on pressure on the right side over the area of the liver and gall bladder.

Urine, golden-brown in colour, is emitted frequently in small quantities. It is rich in bile as is shown by Gmelin's Test.

Constipation persists in most cases. In some, however, diarrhoea sets in later. Appetite is capricious if not altogether lost during the course of the disease. Water is refused. The animal becomes rapidly emaciated and altogether presents a sorry appearance. In a few cases ulcer like erosions occur toward the distal extremity of the tongue and on the dental pad. The breath is fetid and the general odour of the animal is objectionable. Respiration is slow and the pulse feeble.

Death occurs in about 70 per cent. of cases in from twelve to twenty days in uncomplicated cases. Animals surviving that period usually recover.

Autopsy.—On post mortem examination there is no discharge from the natural orifices. The body is usually in an emaciated state. The skin lesions are as described under symptoms. In many cases erosions and shallow ulcers are found on the tongue, dental pad and buccal mucous membranes. Oedema and icterus of the subcutaneous tissues is common. An icteric gelatinous exudate is found in the conjunctival sac and in the brisket. An orange yellow serous exudate is generally but not constantly found in the peritoneal cavity. The content of the rumen is small in quantity but normal in appearance. The omasum contents are unusually dry whilst the remainder of the intestinal tract is practically empty. Small areas of congestion are found in the abomasum and duodenum but they are neither constant nor severe. The icteric condition is general but very prominent along the course of lymphatics and about the hilus of the kidney, joint capsules and inter-muscular septa. The flesh is fevered. The most prominent and constant post mortem finding is always associated with the liver and gall bladder. The liver is always enlarged and friable, varying

in colour from yellowish red to ochre-yellow in different animals. Some livers are slightly mottled. The typical gall bladder found in the disease is tremendously distended, containing up to two litres of bile. The wall being stretched to utmost thinness and in some cases bile is found to be weeping through the wall. Organs in contact with the gall bladder are often found stained with bile. The bile is thick and viscid, no definite blockage of the bile duct has ever been discovered in association with the disease.

The bladder is usually found distended with bile stained urine. All other organs of the body remain normal in appearance.

Pathology.—It would appear from the nature of the lesions that a toxicological principle is contained in the ingested plant *Lantana crocea*, which acts specifically on the autonomic nervous system in such a manner as to paralyse the heat regulating mechanism of the skin and the peripheral blood vessels particularly in those regions supplied by the fibres of the dorsal cutaneous nerves from the cervical sympathetic, the most constant and early skin lesions being found about the head and ears. The internal lesions are all associated with loss of tone in the plain muscle walls of the affected organs, the gall bladder loses its contractile power. The omasum has no longer power to perform its mill-like function and the contents become dry through absorption of fluid from the stationary mass of its contents. The bladder is distended and urine trickles away frequently in small amounts as opposed to the normal large evacuations at greater intervals. Continuous constipation and absence of movement indicate paralysis of the muscle wall of the intestines. All these various functions are controlled by the autonomic nervous system and lesions manifest are such as would be produced by paralysis of that system.

Treatment.—As is indicated by the high rate of mortality, treatment is often unsuccessful. The percentage of recoveries is greater, however, among treated animals than untreated ones. The aim in treatment has been in the first instance to remove as much of the toxic ingesta from the alimentary tract as possible. To this end a purgative drench as follows is usually given:—magnesium sulphate 1 pound, powdered ginger one ounce, tinct of nux vomica one ounce, for an adult. Since the animal refuses to drink voluntarily regular drenching with water must be undertaken. Animals which have recovered have been so treated. Chloral Hydrate in half ounce doses well diluted with water might be given to relieve pain but tincture of opium or morphine is contraindicated for this purpose owing to the paralysing effect of that drug on the bowel wall, an opposite effect being desirable. To increase the tone of the latter organ strychnine in one grain doses or tincture of nux vomica in one ounce doses might be given. Dilute hydrochloric acid in doses of two drachms has been given well diluted with water to prevent the absorption of toxins. Enemas should be given.

The skin lesions have been treated with a lotion composed of potassium permanganate zinc sulphate and lead acetate, of each two drachms in two pints of water, or an ointment composed of zinc oxide and bismuth sub-nitrate of each two drachms, lanoline two ounces and lamp black sufficient to make the ointment black.

Economic Importance.—The number of cattle actually lost through this disease has not been great and since the cause of the disease is happily now known losses can be avoided. Formerly, however, the position was alarming, local butchers did not feel confident in bringing cattle to the Suva district for slaughter owing to the prospects of the deaths of several. Movements of cattle were retarded and breeders were loath to import cattle or to purchase

where it would be necessary to move their cattle through the Suva district enroute to their destination.

Occurrence in Other Countries.—Naturally, occurring cases of the disease are recorded in Queensland but the causal plant is recorded as *Lantana camara* and *Lantana sellowiana*.^{8 9} The disease has been produced experimentally at the Veterinary Research Station, Glenfield, New South Wales.¹⁰

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Owing to delay in receipt of blocks, photographs prepared by the author will be published in a subsequent issue.

NOXIOUS WEEDS AND THEIR CONTROL IN FIJI.

By. H. W. SIMMONDS, F.E.S., Government Entomologist.

PART II—BIOLOGICAL CONTROL.

THE control of weeds, always a serious problem in agriculture, becomes particularly so when those weeds invade grazing lands, or such permanent cultivation as coconuts or rubber, where the return per acre leaves little margin for hand eradication or the use of chemical methods. In such situations weeds of a perennial type are apt to take possession as opposed to the annual types which more frequently occupy ploughed lands. These weeds are usually of foreign origin and are often of quite minor importance in their homes, their success in their new environment being due to their finding some special facility for seed distribution *i.e.* some agency such as doves or mynah birds which feed upon their fruits and scatter their seeds, or an absence of enemies which reduce their seeding power. It will also generally be found that they are distasteful to cattle and thus these animals, by selecting the more desirable growths and avoiding the weeds, favour the spread of the latter.

In such cases it has been felt that the introduction of those agencies which, in its own home land, hold the weed in check, would be the most efficient and economic method of bringing about their control. Such a method has much to commend it, since control, if attained, would be permanent. Still, until recently, it could not be said that very great success had attended the efforts made, from time to time, in this direction. However, the results recently obtained in the control of prickly pear in Australia, by means of a pyralid moth, *Cactoblastis cactorum* aided by two other insects *Dactylopius tomentosus* and *Chelinidia tabulata*, have been most spectacular and give encouragement for further efforts of the same nature.

It must not, however, be thought that such results can in every case be attained. It will often be found that the weed is closely allied to some cultivated crop, when the risk that any agency which attacked the weed would also attack the cultivated crop, would be too great to be taken.

Seed Destroying Agencies.—In many cases the most efficient controls

will prove to be seed destroying agencies and these do not kill the host plant, which still has to be eradicated by hand. They do, however, reduce its powers of seed production so that, when a piece of land is cleared, it is not immediately resown from adjoining waste areas. Such seed destroying agencies are frequently specific and thus likely to be the safest, as well as the most efficient.

Noxious Weeds in Fiji.—The principal noxious weeds of permanent cultivation in Fiji are:—

Lantana crocea.

Psidium guayava.

Clidemia hirta.

Solanum torvum.

Stachytarpheta indica.

Micania scandens.

Lantana.—This plant, a native of Central America and now a major noxious weed in many parts of the tropical world, was probably the first plant the control of which was attempted by biological means. In 1902, Koebele visited Mexico and collected a large number of insects which he forwarded to Hawaii for the control of the weed in those islands. Of these introductions, eight were successfully established and undoubtedly by their combined efforts, lantana is very largely checked in its growth and power of spreading. Thanks to the courtesy of the officers of the Hawaiian Sugar Planters' Association certain of these insects have been obtained from Hawaii and introduced into Fiji. The first of these introductions was made about 1912 when Jepson successfully introduced the seed-eating fly *Agromyza lantanae*, Frogg.

Further control seeming desirable, a consignment of the flower eating butterflies *Thecla echeon* and *Thecla agra* was obtained in 1921. The former was liberated on Taveuni and the latter at Suva. Only the latter established itself, being now abundant on Vitilevu and Ovalau.

In 1927 the writer visited Honolulu and returned with a large consignment of a leaf sucking Tingid bug, *Teleonemia lantanae*, Dist. This was probably the most successful of the introductions in this country for, although for a time in doubt owing to the attacks of another bug, *Germalus pacificus*, it has since spread rapidly, passing through the affected areas like fire. It does not, however, kill the plant, except under special circumstances, but for the time being, prevents any attempt at flower and seed formation.

Clidemia hirta.—This plant is also a native of Central America, where it has a number of allies. As far back as 1920 inquiries were being made on behalf of this Colony as to the agencies which there held it in control. As a result of these inquiries Urich investigated the plant in Trinidad and discovered a thrips, *Liothrips urichi*, Karny. In 1927 T. H. C. Taylor, who was working on scale parasites in that country, made a preliminary investigation upon the insect and reported favourably, whilst the following year a careful study made by W. Cook, a student at the Imperial College, showed that it was not likely to attack any economic plant.

In 1929 the writer was sent to Trinidad to introduce a colony of the insect into Fiji, which was successfully accomplished. Whilst collecting this colony he discovered a number of previously unsuspected insects, which, by destroying the seeds of the plant, were in that country doing much to prevent its spread. These insects are now being studied by two students of the College, with a view to the possible use of some later, in Fiji.

Distribution of Colonies of Liothrips in Fiji.—A strong colony of about 20,000 of this thrips was landed in Fiji in March, 1930. From this liberations were immediately made at Tailevu, Nasinu and Lami. The work of breeding and liberating colonies was then continued by Mr. Taylor, who

distributed between 35 and 40 consignments up to the end of August. These were released at Tailevu, Nadarivatu, Sawani, Taveuni, Wainunu, Navua, Ovalau, Sigatoka, Rabi and Savusavu. These consignments were sent out either as colonies of adults or on growing plants in tins, with all stages present. It is still early to give any definite opinion as to what the result of these liberations will be. The insect is small and not easily seen until it reaches considerable numbers. In December, Mr. Taylor found that the Savusavu colonies were well established and spreading, whilst in February, eleven months after their first liberation, the colony at Lami had spread 200 yards, and the Nasinu colony was also established but weak. This is the wet season when normally the insect receives a set back, and judging by the spread of lantana insects it will require at least two, possibly three seasons before any judgment can be made as to its adaptability and powers of increase.

Stachytarpheta indica (Blue Rat Tail).—Like the preceding two, this also is a native of Central America, and, when in the West Indies, the writer made a preliminary investigation which gave encouragement that it might be possible to do something to check the spread of this plant biologically. It was found that a certain proportion of the seeds were destroyed, but the agency was not definitely proved. It was probably a *Cecidomyiid*, but, if so, was very heavily parasitised. The elimination of the parasites would of course greatly increase the efficiency of the control.

Limits of Biological Control.—Biological control of noxious weeds is only possible where the weed which it is proposed to attempt to control is not nearly related to any cultivated crop. For this reason the use of this method against *Solanum torvum* is out of the question.

As control will usually take the form of reduction of seeding, the plant, if a perennial, will continue to thrive and will still have to be eradicated mechanically. The benefit attained by the control will be the prevention of resowing when once the land is cleared.

Finally, it will probably be found that many of the agencies which help to check the spread of a weed in its own country are too general in their feeding habits to risk introducing into a new country. Nevertheless, sufficient success has now been achieved to justify, in the writer's opinion, further efforts in this direction within the limits mentioned above.

NOTES OF CONFERENCES ATTENDED IN 1930.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

I HAVE to report that I visited Great Britain in 1930 in order to attend the Entomological Conference held in London in June of that year as representative of Fiji. I also represented the Colony at the Imperial Fruit-growers, International Horticultural and International Botanical Conferences held during the same season. Whilst in Great Britain visits were paid to East Malling (2), Rothamsted (2), Cambridge, Long Ashton and Aberystwyth Experimental Stations and Farnham Royal Entomological Laboratory. At East Malling attention was given to the work done on the interrelation between stocks and scions. It had been found that the ordinary commercial stocks were seedlings, genetically impure and, consequently, variable. By the use of stocks obtained vegetatively, uniformity of results was obtainable.

2. It was then observed that different strains, thus propagated, were capable of so far affecting the scion as to vary the date of first fruit production from three to twelve or even fourteen years. The stock also showed effects upon the colouration of the fruit.

3. At Long Ashton further work on the same subject seemed to show that this effect of the stock upon the scion was dependent upon the presence of a portion of the main stem and that, if the graft was made direct upon the root the scion took control and the root then assumed the characters typical of the root system proper to the scion, irrespective of any inherent variation in the types of stock used.

4. At the time of my visiting Rothamsted a demonstration in the use of Adco in the manufacture of artificial stable manure was in progress. It was interesting that the product, which in this case was manufactured from oat and wheat straw, possessed the characteristic smell of the natural article. At this Station virus disease of tomatoes and black spot of cotton were under investigation, the former also being investigated at Cambridge. In the control of these and similar diseases the production of resistant varieties seems the most promising line of research, although where possible this should, of course, be accompanied by the destruction of the insect vectors. It was stated at the Botanical Conference in reference to this subject that "disease resistance was not to be considered as exceptional or infrequent" and a number of instances were given of the methods by which the plant brought about this resistance. It was shown that vascular *Fusarium* wilt of tobacco was, in resistant varieties, controlled by a "corking out" process. Susceptible varieties, when grown under optimum temperature conditions, were often able to overcome the disease by the same methods, although at less favourable temperatures they lacked this power. In wheat and maize susceptibility or resistance to certain diseases was due to the chemical nature of the contained sugars.

5. *Aberystwyth Experimental Station*.—The work at this Station dealt with grasses, oats and clovers and was particularly interesting as showing the improvements which could be effected in these crops by the isolation of pure strains. From typical New Zealand and Danish cocksfoot grasses a large number of very different types had been isolated, many of which would give yields of food or hay, per acre, far in excess of the ordinary commercial seeds. In clovers also similar striking results had been obtained, the variation taking the forms of percentage of leaf, spreading or erect habit, weight per acre, &c. From the same original parents of red clover, types two feet in height were produced and flat dwarfs, not half an inch across.

6. Three visits were paid to Farnham Royal, the recently established entomological centre for the collection, breeding and forwarding of insect parasites from Europe to such other portions of the world as may require them. Arrangements were made with this Institution for the collection and forwarding of a consignment of the fly *Mesembrina meridiana*, the larvæ of which, living in cow droppings, feed upon housefly and other maggots.

THE CONFERENCES.

7. *The Entomological Conference*.—This Conference occupied from June 17th until the 27th. Many subjects, such as Tsetse fly and locusts, of little interest to this country, came up for discussion and in reporting this and the other Conferences it is only proposed to touch upon those subjects likely to have a local interest.

On the opening day Legislation came under discussion and the necessity for its simplification and standardisation stressed. There was a general feeling in favour of closer co-operation and linking up of Entomological Divisions, especially amongst the African delegates, in order to prevent overlapping and lead to continuity of work. Such problems as the Rhino-

ceros beetle in Samoa also are a constant menace to the surrounding groups and any method of co-operation which would assist the affected country in overcoming the pest would not only benefit the affected country in question but would minimise the danger to all neighbouring Groups. In discussing the best methods of dealing with pests where native cultivators were the rule, the opinion was expressed that much better results were obtained through the Chiefs where tribal authority was still maintained, than where this had broken down and the cultivator himself had to be treated with direct. Sometimes the production of a resistant stock, such as the nematode resistant coffee in the Congo, or the Jassid resistant cottons were very helpful.

9. A discussion on cultural methods in dealing with insect enemies was opened by Mr. Stockdale. It was shown that some pests could be checked by such means, thus mosquito blight of tea could be overcome by increasing the amount of potash in the sap, on the other hand reduction of shade in cacao often led to an increase of thirps. In the West Indies it was stated that Banana Borer (*Cosmopolites sordidus*) was almost negligible where clean cultivation was practised, on the other hand clean cultivation of sugar in Antiqua gave much greater attacks by *Diatraea*. Of interest to Fiji was the statement that sheep maggot fly attacks were often a sign of stomach worms.

10. In discussing the biological control of insect pests, methods of breeding parasites *en masse* were demonstrated with lantern slides and details given of work in progress in different parts of the Empire. Of great interest to this country was the subject of the biological control of noxious weeds, the practical utility of such methods having been much doubted until recently. The wonderfully spectacular destruction of Prickly Pear in Australia was, however, very convincing as to the value of insect control where the weed is not closely allied to any cultivated crop. Of interest also to Fiji is the fact that they are also experimenting in that country with a Trypetid fly *Exansia aequales* for the control of Noogoora burr.

11. *Imperial Fruit Growers International Horticultural and International Botanical Conferences*.—These Conferences followed each other consecutively and, as they overlapped to some extent in the matters dealt with, they will, in this report, be treated as one.

12. From the point of view of this country the most important subject discussed was the citrus industry. The increase in the consumption of this group of fruits in Great Britain was enormous, having risen 50 per cent. between 1914 and 1924, with a further increase to double by 1929. The increase in the consumption of grape fruit was said to be amazing. In addition to Great Britain there were considerable markets for these fruits in Canada and New Zealand. It was felt that whilst there was undoubtedly much planting up taking place in South Africa, still there was room for considerable expansion within the Empire, especially for grape fruit. It is proposed to summarise and circulate the facts on the subject.

13. Of special interest to Fiji was the fact that for the past three or four years tropical oranges and bananas were being shipped in increasing quantities from Brazil to the United Kingdom. It was stated that there was difficulty in interesting the trade in new fruits, but that a shipment of mangoes from India fetched good prices in London last year.

14. Details were given of the work of the New Zealand Fruit Control Board, which handles the export fruit of that country. This Board had statutory powers and had proved so successful that since it commenced operations in 1925 exports had increased sixfold (?). The Board consists

of four members elected by the growers and two appointed by the Government. They do not attempt to dictate prices, but distribute the fruit as they are guided by results. They also grade it and regulate the shipments, arranging transport and consigning to their local representatives, who distribute to brokers. They are financed by a levy not exceeding three pence per case.

15. I was informed that, in the West Indies, the cost of grape fruit landed on the London market works out at about 14s. to 15s. per case, whilst it fetched from 18s. to 40s. per case, top prices being obtained for late shipments. From that point of view Fijian fruit would come in when prices were high in the Northern Hemisphere. Citrus seeds have been most successfully shipped in an acid sugar culture media, having been first externally sterilised. They are apagamis, containing two to six embryos and, it is inferred that only one shoot will be cross fertilised and that the others will be vegetative and thus of the same genetic composition as the female parent. This means that in raising citrus from seed 50 per cent to 75 per cent. will breed true to the fruit that the seed was taken from, which will account for the continued production of certain types of orange in Tahiti, &c. It was also stated that as far as productivity was concerned plants raised on their own roots had been found to be as good as those on the various grafts. The necessity for obtaining genetically pure strains, both for stocks and scions was stressed by Cheeseman. In certain groups, however, such as monocotyledons, he was of opinion that advance would be best obtained by selecting good types, as the isolation of pure lines would take a long time.

16. It was stated that the variability of cacao seedlings was immense. As showing these differences Freeman quoted the case of eight trees in Trinidad which only averaged three pounds of dry cocoa per annum. These were cut out and replaced by a high yielding strain, when, after an interval of four years, a yield of thirty pounds was obtained. It was added that most estates had twenty to thirty per cent. of non-paying trees.

17. Much interesting information on bud grafting of rubber in Java, was given. The best clones gave five to six times the yield of average seedlings, but they did not in all cases pass this quality on when grafted. Certain clones had, however, been obtained which did so when it had been found that they not only gave a higher yield (2 to 3 times) but also produced a greater area of latex yielding bark, even giving good results at six feet from the ground. As a result of this work the yields in certain areas had been increased threefold and even better results might be anticipated in the future.

18. In another Javanese product, cinchona, it had been found better to use seedlings of high yielding types as a first planting on new land, but when making a second planting grafts on hybrid stocks were more satisfactory.

19. Both at the Conferences and when visiting the Experimental Stations every effort was made to obtain information regarding the inter-relation between stocks and scions as it was felt that this might prove of value in citrus work in Fiji. At the Conference figures were produced, showing that in rubber the stock controlled the rate of growth of the scion, but at the same time there was a marked effect of the scion upon the root growth of the stock. The East Malling and Long Ashton experiments of a similar nature have been already mentioned.

20. Many different stocks are in different parts of the world used for citrus, the favourites being sour orange, lemon and shaddock. In some

places, such as Tahiti, oranges are grown on their own roots, as also are mandarins, whilst limes are almost always so grown. It was stated that in the United States of America sour orange gave variable results, probably being less pure genetically than the sour orange used in the West Indies. Dr. Yasami of Japan informed me that in that country two stocks were in common use, one being apparently of the sour orange type and the other being *Citrus trifoliata*. In reply to my inquiry as to the effects of these different stocks, he stated that the former produced a strong growing, disease resting plant, but that the fruit was not so fine in texture as that from the *C. trifoliata* grafts and that it took longer to come into bearing, but was longer lived.

21. Considerable time was given to cold storage problems. With bananas, reduction of oxygen without increase in the C.O. 2 in the atmosphere in the holds was advantageous and there were indications that this line of research might open up new methods of transporting fruit. It was further observed that high potash and phosphoric acid content of soil and fruit were associated with good keeping qualities.

22. Another point of interest was an attempt made to determine the connection between the quantity of mould spores present in a field and the wastage of the fruit of that field in storage. Exposed plates gave a range of from 3 to 700 mould colonies on a given surface and these counts were found to bear a definite relationship to the storage wastage, thus indicating the importance of effectively disposing of all waste fruit in the field.

GENERAL.

23. *Horticulture*.—Of more general interest were some notes on propagation given by Stewart of Edinburgh. He stated that cuttings started best in an acid soil, such as is produced by a mixture of quartz sand and pumice and that if the litmus test became alkaline a solution of 2 c.c. of glacial acetic acid to 1,000 c.c. of water was used to correct this. He advised against the removal of the leaves which he said should seldom drop off, but added that in spiny plants it was best to remove the spines. Pith was a deterrent to root formation. Oxygen was necessary in the soil water, the addition of hydrogen peroxide to the water when watering sometimes gave great increase to root formation.

24. The presence of much nitrogen in a seed bed was harmful, leading to leaf rather than root formation.

25. It was also stated that, when grafting, the use of wood from older trees for scions generally resulted in earlier flowering.

26. In conclusion I wish to express my appreciation of the opportunity thus afforded of meeting, not only other Entomologists, many of whom I have corresponded with for years, but also a number of Agricultural and Horticultural workers from all parts of the world whose work is very closely associated with Entomology.

EXTRACTS FROM QUARTERLY BULLETIN OF THE IMPERIAL BUREAU OF ANIMAL GENETICS.

THE Department of Agriculture maintains correspondence with the Bureau of Animal Genetics through the official correspondent (Senior Veterinary Officer). The Bureau is made use of to obtain the latest information on the breeding of animals, and wherever possible information derived in this Colony which might be considered of use is forwarded to the Bureau. The information is supplied by the Bureau in the form of a *Quarterly Bulletin* and the following extracts are made from issues to date:—

[*Extract from Quarterly Bulletin, No. 3, July, 1930.*]

"We would again call attention to the work at the Animal Breeding Research Department which indicates that the genetic factor distinguishing the high milk-yielding cow from her average sisters is probably sex-linked—carried in the X-chromosomes and transmitted, consequently, from dam to daughter and from dam to son to granddaughter, but never through one male to another. After two lengthy statistical studies of the records of over 5,000 cows, Mr. A. D. Buchanan Smith and Miss O. J. Robinson are now able to say definitely that the existence of this factor in the Ayrshire breed can be considered as established. There is also confirmatory evidence from other breeds."

Sterility.—The other main cattle-raising problem which comes within the province of this Bureau and which especially afflicts the owners of improved breeds, is undoubtedly the problem of sterility. That this character has sometimes a genetic basis—particularly when the result of prolonged inbreeding* is beyond doubt; but it seems more frequently to be the result of obscure physiological processes, and therefore lies evenly upon the line which divides our work from that of the Bureau of Animal Nutrition (excluding, of course, sterility that is demonstrably due to pathological conditions). The physiology and bio-chemistry of reproduction in mammals are now being intensively studied at the Animal Breeding Research Department; and it is hoped that before very long sufficient of the rationale of the whole process may become clear enough for us to put definitive data before our correspondents. Meanwhile, they may be interested in a recent brief study of Mr. A. D. Buchanan Smith.

It was first noted that the feeding of sprouted oats to poultry in order to promote rapid growth in the young stock also induced fecundity and high egg production. Next, in America, it was argued that modern methods of husbandry deprived cattle of the flush of young grass during the breeding season, and that this might be a cause of sterility. It was decided to try the feeding of sprouted oats to eleven animals which were sterile but showed no abnormality in the genital organs. After treatment all of them proved to be in calf. In addition, seven heifers were fed sprouted oats before being bred; four conceived at the first service, the others required two, three and four services respectively. The treatment was also effective with six cows and ten heifers. It has not been decided what is the optimum stage of growth at which the oats may be fed. Oats which have barely sprouted and those which have sprouted $2\frac{1}{2}$ to 3 inches have proved effective.

The equivalent of 5 lb of dry oats, *i.e.*, 13–15 lb of sprouted oats, is fed, and conception occurs after a feeding period averaging approximately sixty days. At Beltsville oats have taken the place of an equivalent of silage in the ration.

It is doubtful whether the treatment has any effect upon heifers with cystic ovaries or other abnormalities.

A pedigreed Ayrshire bull, which seemed to be sterile, was sent to the Animal Breeding Research Department and given the sprouted oats treatment. At the end of five months he was proved to be fertile; and there are indications that the treatment has been successful with male goats and one boar (Essex). It is not possible, however, definitely to attribute the fertility of the bull to sprouted oats, since his might be only a case of delayed maturity.

* A. D. Buchanan Smith, "Inbreeding in Cattle and Horses," *Eugenics Review*, October, 1926.

It is, of course, well known that vitamin starvation, certainly of vitamin E, will cause complete sterility in mammals and probably in other orders of the animal kingdom. But the foregoing suggests that there is a further vitamin, perhaps essential only to cattle, which is necessary for the proper functioning of the gonads. Obviously the matter is still in the hypothetical state; and further evidence, practical or scientific, would be of great assistance to most of our correspondents.

Turning now to the problems more peculiar to the tropical and sub-tropical Colonies, we would call the attention of correspondents to a recent publication of the Philippine Islands Bureau of Agriculture, *How to Build up and Improve a Herd or Flock**, which contains many facts and suggestions of great use to the Government Officer who must care for different types of stock, and at the same time cut his coat according to his cloth. The author touches upon that crucial problem of the sub-tropics—the acclimatization of “improved” breeds to unusual conditions; for if this were possible it would render largely unnecessary the prolonged work of hybridisation or of pure selection.

He writes:—“For many years horses, mules, and cattle have been imported into the Philippine Islands from the States, Australia and China, principally”

“As a general rule all the horses and mules that were fed imported feed common to their native land have fared as well from a physical standpoint and have given as long, if not longer, general average service than if they had been in their native countries and employed in the same kind of work as in the islands.

“If for some reason, through change of ownership, or otherwise, these animals are fed exclusively on locally grown feeds, containing no grain like palay or corn, they invariably go from bad to worse and within a comparatively short time become complete physical wrecks, though they may have been in splendid physical condition at the start.

“Native ponies, if fed on imported feed for several years, and in splendid physical condition, will, if turned out on local grass, actually starve to death and that within a comparatively short time”

“Cattle of the highly improved breeds that have been imported for breeding purposes and have been kept up, or stabled, and fed suitable feeds, have also done well. Nearly all of those that were turned out to subsist exclusively on local pastures have quickly become pitiful looking physical wrecks and, sooner or later, died of malnutrition or some inter-current affection largely attributable to the poor physical condition.”

It might at first appear as if we were here trespassing into the field of animal nutrition; but it is impossible to consider the genetics of a beast without regard to environment; and it does indeed seem possible that the inherent unsuitability of the improved breeds in exotic conditions may frequently be only a genetic incapacity to thrive on inadequate or unaccustomed food. It is questionable whether the development of good dairy or beef types even from indigenous breeds would be possible without a corresponding improvement in their feeding and husbandry; and it might therefore be worth the while of animal husbandmen, after some small-scale experimentation, to consider whether they could co-operate with the Agricultural Departments in growing such feed as would enable their improved stock, imported or native, to thrive.

* Kretzer, David C., “How to Build up and Improve a Herd or Flock,” *Bulletin No. 43*, Bureau of Agriculture, Manila.

SELECTING IMPROVED DAIRY SIRES.

Widespread Failure.—To the dairy breeder the selection of the herd sire is a most difficult problem. Recent research has shown that type can give very little indication of economic dairy characteristics. At any one time the number of bulls in a breed which are likely to create a real and positive advance is very limited; 10 per cent. of all the bulls in use would probably be a high estimate. Further, since the qualities of a herd sire in a dairy breed can only be gauged after the daughters of that sire have been raised to maturity, many, indeed, the majority, have gone to the butcher before any estimate can be made of their value to the breed as a whole.

At Mount Hope Farm, Williamstown, Massachusetts, Mr. E. Parmalee Prentice realises these things and believes that the only way to select a dairy bull is on the performance of the bull's daughters. Mr. Prentice has a herd of Guernsey cattle and he does not believe that selection by appearance and pedigree will lead to any improvement whatsoever. In fact, he goes so far as to say that the average dairy cattle, pedigreed or unpedigreed, of any country is no better than it was, fifty, a hundred, or a thousand years ago. He says that he could pick up as good high yielding cows in Poland as he could from amongst the Advanced Registry herds of the United States. Mr. Prentice does not make this statement rashly. He refers to many scientific experiments where, by mating merely on type and pedigree, no real or permanent improvement has been achieved. Particularly he refers to the experiment on poultry of Professor Gowell at the Maine Station, which was begun in 1897 and completed in 1907. Professor Gowell aimed at establishing a flock of hens of high average production by the apparently logical and obvious method of mating high record hens to sons of high record hens. After ten generations of breeding it was found that the average production of the flock was no better than at the beginning. Nevertheless, as Mr. Prentice says, the Gowell System of breeding is continued in many places throughout the country and, as regards cattle breeding especially, it is the method followed by the large majority of breeders.

Success of the Progeny Test.—Great beginnings have frequently led to great disappointments, and Mr. Prentice quotes a prominent poultry breeder as saying, "There is no man living to-day who has a two hundred-egg strain, and there never in the world has been developed a flock of birds that in quantities would average anywhere nearly two hundred eggs year after year." By his methods Mr. Prentice has proved the falsity of the statement. By selecting cockerels from high-producing strains and only using them in the flock after their value was known by means of the progeny test, Mr. Prentice has been able to develop a two hundred-egg strain in a flock of some 700 birds—a truly remarkable achievement. But he has been able to increase on this, and maintains a steady yearly improvement of about seven eggs more per bird per year. Now his average stands at about 213 eggs per bird in a 700 bird flock.

Mr. Prentice is applying the same principles to his Guernsey herd. Unfortunately, the bulls with the best genetical constitution do not always have the best daughters, for it may happen that these bulls were mated to cows of less than average production and that their offspring were so little above the average of the breed that they attracted no great attention, while high records might be made by daughters of ordinary bulls which had been mated to females of high inheritance. These good bulls might be unnoticed, while bulls of less breeding worth are not amongst the well known sires of the breed. To avoid this difficulty, with the assistance of Dr. Goodale an index of the sires breeding ability has been evolved and is employed as the basis of breeding operations at Mount Hope.

An Index of Production.—The “Mount Hope Index” is as follows:—“Compute the average mature equivalent of the milk production of all daughters of the bull; also the average mature equivalent of the milk production of the dams of these daughters, and take the difference between these averages. If the daughters’ averages exceed the dams’ average, add three-sevenths (or .4286) of the difference to the daughters’ average to get the bull’s milk index figure. If the daughters’ average is less than the dams’ average, subtract seven-thirds (or 2.333) of the difference from the daughters’ average to get the bull’s milk index figure.”

“The index for percentage of butter fat is obtained in a similar manner, but with different fractions. If the daughters’ butter fat average percentage exceeds the dams’ butter fat average percentage add three-halves (or 1.5) of the difference to the daughters’ average to get the bull’s butter fat index. If the daughter’s average is less than the dams’ average subtract two-thirds (or .6667) of the difference from the daughters’ average to get the bull’s index. Multiply the milk index by the index figure for percent of butter fat.”

Concerning this index Mr. Prentice states:—“The method of appraising the breeding value of a bull by these index figures has the great advantage that it separates the two factors of milk quantity and butter fat percentage and gives the breeder a definite idea of the bull’s influence on each of these important matters. Of course, like mortality tables and all other indices based on averages, the figures which come out to decimal points can rarely be numerically exact in any particular case. Being based, however, on the actual performance of the individual bull under consideration, the figures will approximate the truth, becoming more accurate as the number of dam-daughter pairs on which averages are based increases.

“The operation of the rule is such that as we pass to low levels of production, differences between dams’ and daughters’ averages becomes less and less, finally reaching zero at the point of minimum production for the breed. Here the sire’s breeding index equals dams’ and daughters’ average production. But there are other differences, non-genetic in nature arising from variations in the health of the animals or from environmental conditions, particularly differences in feed and care, which, magnified by the arithmetical processes used in calculating the index, become obstacles both to genetic research and progress in practical breeding.

“Of course it is impossible, by this or any other existing rule, to foretell the future value of individual untested animals. The rule does, however, enable us to employ a correct method in selecting animals for the test, and gives an intelligible reading of the results of the test when made.”

The Index for Females.—“The rule is applicable to females as well as to males, and therefore, in selecting animals for the test, choice would naturally be made of those which come from parents both of which have high indices. A bull, one only of whose parents has a high index, is, so far as concerns production, a sort of half-breed, and nevertheless not at all to be disregarded where so many pure-breds are less than this. Some young bulls can be found, however, which are not half-breeds, but which come from parents both of which have high index figures. It is upon these bulls that the hope of the breed depends. Other bulls may well be tested, and many of half-breed origin will rank high, but the best chances come with the bulls from highest ranking parents.

“A young bull chosen for the test by this method, if given light service during his second year, may before he is six years old have three or four tested daughters and a number more on test, so that while he is yet young

it is possible to reach a good estimate of his worth as a breeder. A rule which accomplishes such a result as this, is of the utmost value to the entire dairy industry, for it gives to painstaking breeders a method by which they can take their work out of the realm of speculation and make it a matter of system and orderly progress. For those who follow this practice, not only is the tragedy of slaughtering a good bull impossible, as also those other tragedies of keeping animals whose names will occur to many breeders in well-known barns, to the permanent injury of famous herds, but also—what is more important—the means are at hand by which bulls which will raise the production can be recognised.”

Where production can be measured the Mount Hope method is fundamentally sound, as is the basal principle. There are other methods of measuring the progeny test than that employed by Mr. Prentice, and this point is at present under investigation at the Animal Breeding Research Department. It yet remains to be seen whether or not the Mount Hope Index is the best way of measuring the progeny test. It certainly is by no means the worst. In any case, Mr. Prentice, by his vigorous advocacy of the progeny test, is doing a service to all who would improve dairy cattle. We might add that Mr. Prentice's work has attracted the attention of many foreign Governments, and we would wish him every success in it.—A.D.B.S.

Milk and Draught.—The views that it is possible to combine these qualities in the same strain of cattle receives further support in a recent letter from Fiji (Senior Veterinary Officer), Department of Agriculture, Suva, where there is a preponderance of the Australian milking shorthorn breed. “This breed, of course, is famed for its milk production, while the steers grow to such a large size in this country that they are difficult to better as draught animals. . . . they have also been crossed with zebu cattle, and the resulting cross provides the working bullock par excellence. Cows of this cross are also fair milkers and are good mothers. . . .”

[*Extract from Quarterly Bulletin, No. 2, March, 1930.*]

MASS HERD IMPROVEMENT.

An interesting experiment in mass herd improvement is reported from Western Australia. The Director of Agriculture (Perth) writes:—

“Probably the most outstanding factor in regard to “Mass Herd Improvement” is covered by the establishment of the Zone System for the utilisation of pure-bred “above-standard-production” bulls in grading up the ordinary herds in the zones or districts, one breed of bull only being used in each zone with the view of providing a continuity of policy in the grading up of the common cattle.

“Although this policy is not compulsory in the cases of private individuals, it is pleasing to be able to report that it is being closely followed and is growing in importance as time proceeds, in addition to which the Government had distributed 400 standard-bred dairy sires, all of which are out of officially tested dams with production above standard and distributed strictly in accordance with the Zone System.

“The allocation of the zones was decided upon after a series of conferences with the breeders, the Council of the Royal Agricultural Society, and officers of the Department of Agriculture, the scheme being initiated by the Department of Agriculture.

“The operation of the “Dairy Cattle Improvement Act” resulted in the improvement of the class of dairy sires in use, as follows:—

"In 1923 there were 177 pure-bred bulls, of which 75 were the progeny of cows that had been officially tested, with production above standard. In 1928 the number of pure-bred bulls was 714, of which 587 are the progeny of officially tested cows, with production above standard.

"Undesirable scrub bulls destroyed or desexed during the period number 1,240."

INDIAN CATTLE.

An authority on Indian cattle has challenged the statement in the last *Bulletin* that the average yearly milk-yield of the Sahiwal herd at Ferozepore "approximates to 9,000 lb or more per cow," which was a quotation from one equally well versed in the subject. It is probable that that figure only refers to exceptional cows, and that the average of the herd is not much above 5,000 lb.

Some further comments on the last *Bulletin* come from Dr. D. Clouston. He writes that the Indian breeds of cattle are much more resistant than the European to contagious abortion—"Some of our veterinarians in India attribute the prevalence of contagious abortion on the military dairy farms to the introduction of exotic blood (mainly Ayrshire and Holstein) into the herds."

He also mentions that the Indian cattle of the plains, but not the hill cattle of the Himalayas, are decidedly more resistant to rinderpest than are European cattle, and require a less massive inoculation. On piroplasmosis his comment is: "Indian cattle are remarkably tolerant to the germ of this disease. It is in their blood, but the germ does not appear to become active until and unless the host gets run down in condition after an attack of rinderpest or as a result of starvation."

A GENERAL PURPOSE HORSE.

A general-purpose horse of an unusually good type has been achieved in Canada by selection of the French-Canadian horses. These horses first appeared in Canada when Louis XIV of France sent out a few of his best specimens to the new Canadian colony. Little attention seems to have been paid to them at first, which was, perhaps, all to the good, since natural selection in that cold climate with bad winter roads did its work in eliminating all except those of very high vitality and endurance. Then in 1912 the Experimental Station at Cap Rouge started selecting these French-Canadians and breeding up a stock. They have been quite deliberately bred—mainly by inbreeding—for general purposes, and the resulting horses are reported to be useful and attractive animals. Usually black in colour, rather like a large Welsh cob, they are said to look and trot well in a trap or even carriage, and, at the same time, when put to heavy labour seem able to outwork bigger and heavier team-mates of other breeds. They are described as docile and kindly animals that put their hearts into their work, and can even endure a Canadian winter in open-fronted, single-boarded sheds without suffering. Apparently too, they are not limited to a cold climate, since a team was sent out with the Royal Canadian Artillery to South Africa for the Boer War, and returned unaffected by the climate.—EXPERIMENTAL STATION, CAP ROUGE, QUEBEC, CANADA.

EPILOGUE.

It is the desire of the Bureau to build up a picture gallery of the live-stock of the Empire, since a good photograph is of more value than any description in indicating the type and points of a beast under consideration. Moreover, the Bureau is now engaged in preparing the material for a mono-

graph on the phylogeny of the domestic animals, and is also co-operating with the Bureau of Animal Health and Animal Nutrition in a rapid survey of the live-stock of the Empire and their commercial potentialities. We should therefore be very grateful to any correspondents who would send us photographs of their animals, particularly of the indigenous types and first and later crosses, and so enable us to be of more assistance when consulted.

PINEAPPLE CANNING

By D. H. GRIST, Agricultural Economist, British Malaya.

FACTORY methods for canning pineapples vary considerably between Malaya and the other countries of production, notably Hawaii. In the latter country, machinery is used as much as possible, whereas in Malaya, owing to its relative cheapness, hand labour is employed for almost all the operations. It is a curious fact that while in Hawaii the cans are purchased from a central can-making factory, in Malaya each factory is equipped with a complete can-making machinery.

A further marked difference between these two countries is that in Malaya the factories are generally established in close proximity to the pineapple plantations. The most distant are the five factories in Singapore, which draw the bulk of their supplies of fruit from Johore—a matter of perhaps 30–50 miles by road. The nearest to the centres of production are in Johore where there are twelve factories, situated so close to the fields that transport is reduced to a minimum. The principal factories in Hawaii and Africa may be situated a considerable distance from the plantations. The nearest plantation to the largest Hawaiian factory is twenty-five miles distant. The Port Elizabeth factory is 125 miles from the estate, the latter being intersected by over 150 miles of roads.

The fact that by the Malayan method, transport both of fruit and empty cans is reduced to a minimum, has its advantages. The fruit can be harvested in a riper condition than would otherwise be possible, while the factory methods are such that generous use is made of labour—which is comparatively cheap; while freight—which is comparatively expensive, is reduced to a minimum.

The question of power must also be considered in connection with situation and size of factory. In Hawaii, electricity is used at a cost of from 2–4 cents (gold) per kilowatt. In Malaya, the power required for a factory of 1,000–1,500 cases per day can be supplied by an engine of 15–20 h.p.

CAPACITY OF FACTORY.

Factories in Hawaii are capable of turning out 1,500 cases per day; one factory is said to have a capacity of 4,000 cases a day. The largest output by a factory at Port Elizabeth, South Africa, is stated to be 2,300 cases per day. From a consideration of the number of factories working, the methods employed, and the total quantity of canned pineapples exported, it is evident that the average capacity of a Malayan factory is lower than that of Hawaii or Port Elizabeth. Probably from 1,000 to 1,500 cases per day is the utmost limit of our local factories, while the capacity of the majority is even less.

COST OF FACTORY.

According to an Hawaiian authority, the cost of machinery, (excluding the cost of the buildings) capable of producing 1,500 cases per day, would be the equivalent of about \$90,000 (Straits Currency). An important pineapple

packer in Malaya published a statement in 1927 that "about \$150,000 capital is necessary for an ordinary pineapple factory and for a factory of bigger capacity \$300,000 will have to be invested." These figures, obviously, include working capital. The machinery in a Malayan factory with a capacity of 1,000 cases a day may be between \$13,000 and \$20,000 excluding shafting, power and cost of building.

The following details of factory methods refer to Hawaii and South Africa. The Malayan methods are so different, that they will be stated subsequently.

CAN-MAKING.

Hawaiian canners do not manufacture their own cans, but purchase them at \$28 (gold) per 1,000 from a can-making factory. A similar system is employed in Formosa, where the areas under the crop are somewhat scattered.* The Port Elizabeth factory manufactures its own cans with a plant capable of producing 30,000 to 35,000 cans daily.

A machine cuts the tin-plate to the requisite size for the body of the can. Flanges are then cut at each end of the body section to make the hooks or edges which will interlock to form the two side seams. It is then rolled to a cylindrical shape, double seamed, interlocked and automatically soldered. The bottoms and tops are cut out and shaped by a press, the bottom being then fixed on a by seaming machine. Rubber solution (in Malaya, a thin band of rubber, locally manufactured) is applied in a groove on the outer edge of each disc; this renders the use of solder unnecessary and ensures that the cans are airtight.

PEELING, CORING AND SIZING.

The "Ginaca" machine automatically performs the operations of peeling, coring and sizing. It is made in three sizes; Viz., No. 2½, No. 2, No. 1. It has the disadvantage that it will only prepare fruit of one size diameter and cannot be adjusted to fruits of different sizes. The 2½ "Ginaca" will handle about 38 pines per minute. It is made by the Hawaiian Pineapple Company and costs \$5,900 (Gold).

In the operation, the pines climb a chain conveyor and are placed in position. The machine then cuts off the skin in two pieces, cuts off the top and bottom, extracts the fruit still adhering to the skin, then cores the pine.

The fruit is then conveyed to a trimming table, where any irregularities are rectified by hand.

A slicer is then employed, also made by the Hawaiian Pineapple Company, costing \$2,000 (Gold), which cuts the fruit into slices about half an inch thick.

CANNING.

The fruit is graded as it proceeds along a conveyor. The usual method is for certain of the workers to be responsible for picking out the best for "fancy" quality, others being responsible for standard quality—the remainder being broken pieces.

The broken pieces are conveyed to vats where they are broken up and boiled, becoming crushed or grated and packed in cans for special markets.

Cans containing slices are taken to a vacuum machine, costing \$1,800 (gold), which removes most of the air, and thence to the Syrupping Machine

* The pineapple canning industry in Formosa is relatively small, but is rapidly increasing.

(\$1,100 gold) which fills them with sugar syrup and thence to the Exhaust Box, a steam chamber, where they remain for six minutes at a temperature of 210°F.

The Double Seamer (\$2,500 gold) places the lid in position, bends the edges down and under, after which a second machine flattens them hard in this position.

The cans are then sterilised for seven minutes at a temperature of about 222°F., and placed in a Lacquer Bath (\$250) which improves the appearance of the can and is said also to retain the can in an airtight condition.

Subsequently the cans of fruit are dried and stored until labels are affixed.

SYRUPING.

The syrup with which the cans are filled is prepared with cane sugar and water, pineapple juice not being employed in its preparation. O'Conner, reporting on the South African product states:—"Different syrups are used according to the variety of grade of fruit canned. As the 'Giant' or 'Cayenne' pineapple is less sweet than the 'Queen' variety, more sugar is used in preparing the syrup in which it is preserved."

The following is the percentage of sugar used:—

- For Queen Pines, 1st Grade fruit 27 per cent sugar
- For Queen Pines, 2nd Grade fruit 16 per cent. Sugar.
- For Cayenne, 1st Grade fruit 40 per cent. sugar
- For Cayenne, 2nd Grade fruit 30 per cent. sugar

Under the Canadian regulations affecting the importation of canned pineapples, the following are laid down respecting syrup:—

- "Heavy Syrup" for pineapple will be considered as that syrup which cuts out not less than 23 per cent. Balling at 60°F.
- "Light Syrup" for pineapples will be considered as that syrup which cuts out not less than 17 per cent. Balling at 60°F.

MALAYAN FACTORY METHODS.

The operation of peeling and cutting or slicing are always performed by hand. Grading is performed by the worker during these operations.

The following machinery is usually employed in a Malayan pineapple canning factory.

Foot Shears, for cutting the tin-plate into strips. Cost varies from \$300 to \$500 (Straits Currency). Two such machines are necessary in a factory having a capacity of 1,000 cases per day. Each machine can be worked by one man.

Roller Shears, for cutting the body strips for 1½ lb flat size. The machine will cut six strips at a time. One such machine required: cost about \$1,000.

A locally made hand machine, costing about \$25 each is employed for rolling the body pieces. From five to ten machines of this description are used in a factory.

The edges of the body pieces are then notched by hand with a pair of scissors.

Soldering.—Lap-soldering of the body pieces in cylindrical form is performed by hand. The usual contract price for this work is 11 cents per 48 cans.

Automatic Bordering Machine, prepares top and bottom edges for double seaming. Two such machines, costing about \$500 each, each with

a capacity of 3,000-4,000 cans per hour are used Each machine can be worked by one man

Punching Press, for cutting tops and bottoms; three or four such machines employed at a cost of about \$900 each The dyes of different sizes for these presses are locally made and cost from \$100-\$200 each according to size.

Double Seamers.—For seaming bottoms to body. Cost \$700 each. Two machines of this description are used for the bottoms, and another two for the lids. Capacity, about 1,500 per hour for each machine.

GRADES.

Malayan pineapples are packed in three grades, viz:—Special Golden, Good Average Quality (G.A.Q) and Number 3. No. 2, now less frequently prepared, finds a market in China. The popular description is cube, although slices and whole pines are prepared for special markets. Several descriptions of shapes of tin and weights of content are marketed, although the tendency recently has been to reduce the number. A case of pineapples may contain 48 cans of 1½ lb each, a case of 2 lb cans may contain 24 or 36 cans according to whether the packing is of whole pines or slices, while the packing of 2½ lb cans invariably has 24 cans to a case.

In Hawaii, the “sliced” is packed in two grades, “fancy” and “Standard” and apart from “Crushed and Grated” and one or two Special packings, only round cut sliced is made.

BY-PRODUCTS.

Only about one-third by weight of the pineapples received in the factory is utilised. In Malaya, no use is made of the waste from the factory. Greenstreet and Gunn Lay Teik* shew that for the economic disposal of the waste, the removal of the juice is essential. They describe remunerative methods of disposal of the partially dried waste, and also shew that the fermentation and distillation of the fresh juice for the production of a potable alcoholic liquor similar to brandy is a simple process. As far as the present writer is aware, no factory in Malaya has commercialised these results.

COST OF CANNING.

It is stated that canned pineapples can be produced in Hawaii at £20 per ton delivered to the consumer, the factory cost being about \$1.50 (gold) per dozen cans.

The African costs are said to be £5 per ton for fruit, and £5 per ton for cost of manufacture.

In 1927, a Malayan pineapple packer published the following statement of the factory costs per case of 72 lb:—

16 sheets of tin plate	\$1.65
Lead and soldering	0.10
Good White Sugar	0.80
One empty wooden case	0.50
Labour	0.40
Water and fire wood	0.20
Rubber stripping	0.10
General expense of the factory	0.75

a total of \$4.50 per case of 72 lb to which must be added the cost of the pines (80 medium quality pines per case, costing from 1-2 cents each).

* “By-Products of the Pineapple Canning Industry” by V. R. Greenstreet and Gunn Lay Teik.—*Malayan Agricultural Journal*, Vol. XVI, No. 1, January, 1928.

The total cost per ton on this computation would be \$186 or approximately £22 ton. In view of the fact that the price of canned pineapples in Singapore is below this figure, it must be supposed that packers have been able to reduce their costs of production. In any case, the above statements of costs in different countries must be taken, at best, as only a rough approximation.

In conclusion, the writer has tried to shew that the Malayan pineapple canner has endeavoured to establish a market for a cheap but good quality product. This has been made possible by the following means; employing cheap labour, treating pineapples as a catch crop, placing the factories near centres of production, and producing a less elaborate and unlacquered can. The market now established, the quality of the product has been improved, and there would appear scope for further extension of the industry.

In the preparation of the above article, the writer is indebted for considerable assistance from the following sources: Notes on the Pineapple Industry in Hawaii, from a private source; The Pineapple Industry in South Africa from a Report by Mr. C. A. O'Conner of the Mauritius Department of Agriculture; Mr. P. T. B. Hansen of Singapore; The Empire Marketing Board Reports; and data collected from time to time by various officers of the Department of Agriculture, S.S. & F.M.S.

COCONUTS.

British Malaya.—The following particulars are taken from a report of progress in relation to coconut research up to June 30, 1930, furnished by the Department of Agriculture.

Ceylon Coconuts.—The Agriculturist visited nine estates in the North-West Province of Ceylon for the purpose of investigating the various methods employed in the cultivation of coconuts and the preparation of copra. The results are embodied in a report which has been published in the *Malayan Agricultural Journal* (1930, 18, 378) and the chief points therein may be summarised as follows:—

1. There are approximately 1,000,000 acres planted with coconuts in Ceylon.
2. The annual rainfall in the areas visited ranges from a minimum of 45 in. to a maximum of 103 in. per annum (Malayan limits 40 to 230 in.).
3. The soils range from light sand to very light clay (lighter than Malayan coconut soils).
4. The estates generally vary in size from 400 acres to 1,000 acres.
5. Planting is between 60 and 70 palms per acre, but this is considered too close, particularly on estates which practise a regular system of manuring.
6. The average age of palms varies between 35 and 45 years (Malayan Estate: 20 years (av.); Native: 30 years (av.)).
7. Clean weeding is not practised and most of the estates are under light grass which is kept grazed by cattle.
8. On a number of estates grass is being replaced by low-growing, leguminous cover plants and *Dolichos Hosei* is generally employed for this purpose.
9. The general practice is to plough to a depth of 6 or 8 in. and then harrow with a disc harrow alternate rows every two years.

10. It is generally recognised that more satisfactory returns can be obtained by the application of artificial manures. The composition of the manures employed varies considerably, but as a rule 8 lb of a complete mixture is applied in alternate rows annually.

11. Harvesting takes place at two-monthly intervals and an average of two bunches per palm is collected at each picking.

12. The heaviest pickings occur during the wettest months, May and July, when the yield is over twice that of the smallest monthly yield.

13. For the nine estates visited the average yield of nuts per palm is 66 and the yield per acre averages 3,940 nuts. (The yield of nuts per palm for estates under Malayan conditions is approximately 50, with an average yield of 2,200 nuts per acre).

14. Only ripe nuts are harvested. The nuts are stored in heaps of from 3,000 to 4,000 in the field for about 4 weeks in dry weather and for 5 weeks in wet weather. Husking is done in the field and transport is by bullock cart or light railway.

15. Kiln drying is the general practice and the system is to dry in the sun for one day on a cement barbecue. The nuts are then placed on the kiln in a layer 12 in. to 18 in. deep and turned daily. After 2 days the shells are removed and drying is completed after 2 or 3 more days—making 5 to 6 days in all. (Malaya $1\frac{1}{2}$ to 4 days.)

16. Special precautions are taken to prevent mould growth in the store-shed, where sorting into three grades of quality is carried out.

17. The average yield of copra for the nine estates was 14 piculs per acre (Malayan estates average 9 piculs per acre).

Arrangements have been made with six estates in Ceylon to supply selected seed nuts from five of their highest yielding palms with a view to establishing small experimental plots in Malaya. Of the first lot of seed nuts, some 300 have been sent to the Experimental Plantation, Serdang, for germination, while the remainder have been examined in the Chemical Division. The full report is not yet available, but the following figures may be quoted:—

	Two Malayan estates.	Nine Ceylon estates.
Average weight of wet meat.	.. 475 grms.	405 grms.
Average oil content (dry basis)	.. 65.6 per cent.	67 per cent.
	(Av. of 60 croppings from different trees.)	(Av. of 35 nuts from from 30 trees.)

Small experimental plots will later be established with these Ceylon nuts on six selected estates in different parts of Malaya, and when the palms eventually come into bearing a chemical examination will again be made of the nuts so produced under various Malayan conditions.

Copra Research.—The following is a résumé of the work of the Assistant Chemist for Copra Research.

The Structure of the Wet Meat in the Nut.—Considerable variations exist in the oil and moisture content of different pieces of wet meat taken from a single nut, particularly if the nut is not ripe. Furthermore, any one piece of wet meat is itself far from uniform in structure.

(a) *Oil Gradient.*—Nuts which have not quite begun to germinate may show an oil percentage of about 35–40 per cent. (dry basis) and a moisture content between 75 and 80 per cent. on the inside face of the wet meat, whereas immediately under the testa or brown skin the oil content will be in the neighbourhood of 70 per cent. to 75 per cent. (dry basis) while the moisture may lie between 20 per cent. and 50 per cent. A more unripe

nut will show a still steeper oil gradient, but, on the other hand, as the nut ripens and begins to germinate the moisture percentage becomes less and the oil content becomes practically uniform at between 68 and 75 per cent. (dry basis) throughout all the layers of wet meat.

These facts have an important bearing on (1) the methods of sampling for purposes of analysis and comparison of individual nuts, (2) the best time for picking to give the highest oil and copra yields per nut, (3) the means to be adopted to dry the copra so as to obtain a white, uniformly well dried, brittle product.

(b) *Structure and Ripeness*.—A long series of comprehensive observations are being made of the physical and chemical characteristics and the structure of under-ripe and over-ripe and just-ripe nuts obtained from high, medium and low-yielding palms.

The results so obtained will provide important information as to the changes occurring in the ripening nut, and, more important still for practical purposes, will indicate definitely what problems have to be faced in drying and the methods which should be adopted to obtain the whitest and most oily copra in the quickest way possible.

It has already been found that:—

1. While the ripe nuts from certain trees regularly show a uniform oil content in the neighbourhood of 63 per cent. others give ripe nuts containing 71 per cent. of oil (dry basis).

2. The ripe nuts from one tree were found to require 189 nuts to produce a picul while another required 360 nuts.

3. When one takes into consideration the average annual yield (for nine years) the following average annual equivalent yields are obtained from the selected palms when ripe nuts are picked.

Palm.	Av. oil content of copra (dry basis). <i>per cent.</i>	Av. nut yield per annum.	Av. No. of ripe nuts per picul.	Equivalent copra yield per acre. <i>(piculs)</i> .
1	67	106	260	20
2	71	107	225	23
3	71	67	360	9
4	63	67	280	12
5	65	27	290	4.5
6	68	16	270	3.0
7	69	104	250	21
8	67	87	180	24

1 picul = 133½ lb

(c) *Ripeness, Oil and Copra Yield*.—Concurrently experiments are being performed on other estates in which the problem is being approached from another point of view. The whole crop from a given area is being divided into picked and fallen nuts, all rotten nuts being rejected. These nuts are then being split and divided into five groups according to the absence or size of the embryo. The number of nuts in each group is counted, and the wet meat is then converted into copra and weighed and finally analysed for oil content and judged for appearance.

On the first estate selected, of over 1,000 nuts examined from a mature area producing 11 piculs to the acre, 486 nuts had fallen naturally, while 498 were picked; in addition 50 ripe unsprouted, picked nuts were taken from an adjoining area and were stored for one month. About 70 per cent. of the nuts were collected in a satisfactory condition of ripeness, whilst the remainder were only slightly more over-ripe or under-ripe. In the circumstances striking differences of copra yield and oil percentage were not brought out. The smallest number of nuts required to produce a picul

of copra was shown by fallen nuts with pea-sized to $\frac{3}{4}$ in. embryo, viz., 188 nuts, the largest number of nuts was required by the just not ripe fallen nuts which required 218 nuts to make a picul of copra. The 50 picked ripe nuts after being kept for one month required proportionally 227 nuts to make a picul of copra. The average yield for the whole area showed that 200 nuts were required to make a picul of copra. When one remembers that Malayan estate pickings average 250 nuts to the picul whilst native pickings take up to 350 nuts to the picul, one is able to appreciate the excellence of the nut collection in this estate.

(d). *Physiology of Growing Nut*.—Experiments are about to start on the weekly comprehensive examination of dated nuts so that the rate of development of wet meat, copra and oil can be studied while the nuts are ripening (i.e., from 200 days old to 500 days old.)

Provisional Conclusions.—It will appear that the best time of picking in order to produce a good uniform type of copra will be when the oil percentage of the wet meat is highest and most uniform, when the moisture conditions are lowest and most uniform and, irrespective of any slight corrosion near the embryo, when the greatest weight of dry meat is obtainable from the nut. It is believed that these conditions are satisfied when a haustorium about 1 in. in diameter is to be found in the plucked nut. Thus only ripe, fully brown nuts should be picked. On the other hand, large quantities of nuts are being picked in this country in a state of extreme under-ripeness, and as a result the copra produced from the very wet meat contained therein is thin, wrinkled, low in oil, and irregularly dry and therefore prone to mould growth and deterioration. Two such nuts will only produce the same weight of such inferior copra as of good oily copra produced from one fully ripe brown nut, and will take longer to dry.

Driers.—Some consideration has been given to the product obtained from a number of different driers, but the more complete examination of the working of each individual drier will be deferred to a later date. The present indications are that drying in Malaya has been speeded up at the expense of the quality of the product as regards oil content, uniformity and amount of contained moisture, and colour. Extra heat applied at the wrong time and with insufficient air movement has resulted in a case-hardened product, with a wet centre, an apparent loss of oil, insufficient and/or irregular drying, caramelisation and in some cases actual burning.

It has been noticed that the drier meat from the more ripe nuts is more prone to yellowing and caramelisation during drying than is the wetter meat from unripe nuts. This fact will have to be borne in mind and the drying conditions will need to be designed so as to overcome this trouble.

In order to work out and develop a standard process to produce perfect copra it is necessary to start with, as far as possible, a uniform raw material. If any unripe or over-ripe nuts are removed and dried separately, the bulk of ripe, brown nuts can be dried under the conditions calculated to produce a uniform and white product of maximum dryness in the shortest time possible.

Types of Copra.—An interesting series of sorted types of copra was exhibited at the Kuala Lumpur Show. The oil content of each type of copra was calculated and an approximate idea of the thickness of the copra was determined. The results show that careful preparation and nut collection is rewarded by a higher oil and copra yield.

It can also be observed that a high oil percentage (dry basis) may indicate either that the copra has been derived from over-germinated nuts, or, on the other hand, that considerable deterioration has occurred.

Type of copra.	f.f.a.	Oil per cent. (d.b.).	Oil per cent. (w.b.).	Average thickness	Relative yield per nut estimated.	
	per cent.	per cent.	per cent.	mms.	Oil.	Copra.
Good F.M.S.	·06	65·6	61·9	9·0	100	100
Wrinkled from unripe nuts	·63	60·0	55·2	5·0	51	56
Thin from over-ripe nuts	3·01	74·2	70·7	4·5	60	52
Burnt and carbonised	·34	64·9	60·3	8·5	94	96
Caramelised and slight insect attack	·24	64·8	61·5	8·5	96	96
Burnt and heavy insect attack . .	1·50	60·1	56·9	7·0	74	80
Slimy, black and rancid	5·01	73·7	68·8	7·5	80	72
Heavily black moulded	5·25	68·3	64·3	8·5	92	88

Good quality F.M.S. copra may show a somewhat low oil percentage (dry basis) from certain trees and areas, but a very low oil percentage is generally indicative that the nuts have been picked young or that the copra has been burnt and/or heavily attacked by insects.

Storage of Copra.—The high oil content shown by mouldy copra after prolonged storage is due to the removal of the inner layers of low oil content by the moulds, the remainder showing a slowly increasing oil percentage as a result. During shipment and handling in storage a heavily moulded copra may dry out when the mould will fall away as dust, leaving the copra clean, frequently still internally white and rich in oil. Furthermore, if inferior copra which has developed, a high degree of rancidity and mould growth is stored under good conditions, the acidity is actually able to diminish while the copra as a whole will become dry and cleaned up.

Six large samples have been stored for three months in airy conditions and the two extreme examples are as follows:—

Copra from Muar.—Light brown, mouldy and slightly attacked by insects—

	per cent.
Original acidity	·72
Final acidity	·42

Copra from Kelantan.—Dark brown, very mouldy and insect ridden—

	per cent.
Original acidity	3·12
Final acidity	·80

All the samples showed a more or less proportional reduction in acidity and finished up dry and mould free.

The explanation of this is to be found in the drying out of the copra. Further acid formation is arrested while the acidity already existing is gradually converted into water vapour and gas. It must be appreciated that during deterioration coconut oil is turned into free acid with considerable heat development and that the free acid so formed is lost with further heat development.

Financial Losses in Storage.—The full extent of the losses sustained by the producer when his copra is piled as a huge stack in an ill-ventilated storehouse, in order to dry out the copra preparatory to weighing, has yet to be determined. Very considerable heat formation and darkening, mould growth and acid formation are found, with the result that a loss in weight due to oil loss occurs and a higher percentage of copra is classified as F.M. owing to deterioration of the good pieces of F.M.S. quality down to trade

F.M. The remedy for this state of affairs really lies with the producer, because if he completely dried his copra it would not deteriorate in storage nor would it need to be stored before acceptance. Furthermore, because of the time and trouble saved to the shipper, he could offer a better price for guaranteed dry copra.

Insect Attack.—Another matter which is receiving attention in the department is insect attack during storage resulting in very considerable losses in copra weight and total oil.

A number of samples of copra have been received from world-wide sources, but owing to detention in transit, the time since despatch has been considerable, with the result that extremely heavy insect attack has resulted. The material has not yet been analysed, but from its appearance, the immense amount of fibrous dust present and the method of attack, it is obvious that the insects have consumed the oil and rejected the fibrous material. The copra is in many cases a mere shell, buried in brown dust; the rich oily copra immediately under the testa has almost in every case been completely removed and attack has taken the form of tunnelling from the soft inner surface of the meat straight towards that oily meat under the testa.

When burnt, "caramelised" and white copra are found side by side, the two former are attacked first, and for a while the white copra remains unattacked. It will be remembered that in the cropping experiment the most ripe nuts produced a caramelised yellow product which was rich in oil. The oily nature of this copra may be the reason for the preferential attack, or alternatively the more pleasant flavour of slightly burnt copra may be the cause.

Existing stores should periodically be cleaned and sprayed with disinfectant, the copra should be piled only in a dry state, and the production of "case-hardened," hastily prepared copra with a hard skin and a soft wet centre should be avoided. It would be better, however, if stores were built with windows and doors constructed of iron gauze so that when clean dry copra is put in, free ventilation is possible, but the ingress of insects is prevented.

EMPIRE FRUIT SUPPLIES, 1930.

The following extract has been taken from the *Weekly Fruit Intelligence*, issued by the Empire Marketing Board, dated 7th January, 1931:—

The year 1930 has in many ways been a notable year for Empire fruit on the British and continental markets so far, at any rate, as the volume of supply is concerned. In the early part of the year, shipments of grapes, peaches and plums from South Africa established new records, and the total for all deciduous fruits throughout the season was little short of 2,500,000 packages, an increase of 900,000 over the preceding season and of 500,000 over the previous record in 1928-29. At the same time Canada was shipping apples from a Nova Scotian crop gathered in the autumn of 1929 exceeding all previous figures, and exports of barrel apples to Europe, for the first time for many years, exceeded the corresponding shipments from the United States, while the close of the Jaffa orange season in May showed total exports of 2,700,000 boxes, or 700,000 more than the previous record in 1926-27.

During the summer months Australia and New Zealand shipped respectively 4,320,000 and 1,100,000 boxes of apples to Europe, the bulk of them to the United Kingdom; in each case these were larger totals than had ever been recorded previously, while, at the same time, shipments of pears

from these two Dominions also reached record proportions. Throughout the summer also, the large South African orange crop was being marketed almost entirely in this country, and reached the formidable total of 1,840,000 boxes, or 740,000 more than had ever previously been shipped overseas in one season, while South African grapefruit exports, exceeding 100,000 boxes, were not much short of double the largest exports hitherto recorded. Towards the end of the year the new Canadian apple crop began to reach Europe in even larger quantities than at the beginning of the preceding season; the 1930 British Columbian crop was the heaviest in history, and although the Nova Scotian and Ontario crops were relatively light, they have moved across the Atlantic in large volume, total shipments from Canada to Europe from the 1930 crop up to the end of the year aggregating some 3,700,000 boxes (including barrels in terms of boxes), as against 2,900,000 at the same time a year ago.

Finally, shipments of bananas from Jamaica during 1930 reached new heights, exceeding the 22,000,000 bunches exported in 1928, and although the United States is the chief market for Jamaica bananas, imports into this country also established a new high record.

FIJI LIVESTOCK RECORD ASSOCIATION.

MEETING OF BOARD OF DIRECTORS, 7TH OCTOBER, 1930.

Present.—Director of Agriculture (Chairman), Messrs. G. Kiss, J. Barber and C. R. Turbet.

1. The minutes of the previous meeting were read and confirmed.

2. Mr. Kiss raised the question of opening a calf register. After discussion it was decided that Mr. Turbet should prepare rules for such a register.

3. Owing to the shortage of veterinary staff it was decided that Rule 47, which provides for the branding of stock with the Association's brand, should not be enforced in the meantime, and that stock should be registered without bearing such brand.

4. It was decided to hold the Annual General Meeting of the Association on the date of the "Tofua's" sailing in January, 1931.

5. It was decided to print the herd-book prior to the Show to be held in October, 1931. The Board was of the opinion that stock entered for competition as pure-bred should be required to be registered in the Association's herd-book.

ERRATA.

In the list of noxious weeds to be found in Vol. 3, No. 3, p. 112, certain botanical names were spelt incorrectly. Thanks are due to Mr. W. Greenwood of the Colonial Sugar Refining Company Limited, Lautoka, first for supplying the names, and secondly for drawing attention to the inaccuracies.

Since the publication of the above *Journal*, the Burr (unnamed) on the same page has been identified by Dr. Darnall Smith as *Urena lobata*, var. *scabriuscula*.

<i>Errata.</i>		<i>Corrigenda.</i>	
<i>Acacia farnesiana</i>	<i>Acacia farnesiana</i> , Willd.
<i>Stachytarpheta indica</i>	<i>Stachytarpheta indica</i> .
<i>Cenchrus echinatus</i>	<i>Cenchrus echinatus</i> .
<i>Elephantis scaber</i>	<i>Elephantopus scaber</i> .

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ORNAMENTAL TREES AND PALMS FOR SALE.

A LIMITED number of ornamental trees and palms is available for sale from the Nasinu Experimental Station. Particulars are obtainable from the Department of Agriculture.

A. C. BARNES,
Director of Agriculture.

12. OCT. 1931
IMP. INST. AGR. RES. PT.

AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 4.]

SECOND QUARTER, 1931.

[No. 2.

EDITORIAL.

CITRUS EXPORTS.

ATTENTION has been paid to the possibilities of increasing the citrus export industry and thus securing higher returns to producers. Oranges and mandarins have figured amongst the minor exports from Fiji for many years, but no proper attention seems to have been paid to the conduct of the business, either by the grower or the shipper. The increasing competition which Fiji has to meet in the New Zealand markets from other Islands of the South Seas should of itself provide a sufficient incentive to those engaged in the fruit export industry of Fiji to take every possible step to see that their fruit is of the highest quality and that it reaches the market in sound and attractive condition. Results of investigations made during the past season are recorded in this issue. They indicate a very real need for the adoption of improved methods of picking, handling and packing of citrus fruit for export and show clearly that increased returns will be obtained by the exercise of proper care at all stages. It does not appear to be generally realised in Fiji that fruit of this nature should be handled as carefully as eggs and that bruises and other forms of skin damage result in fruit rots which completely spoil the fruit for marketing. The methods normally used here result in a very high degree of wastage which causes heavy losses to all concerned. To maintain and develop this important side-line it is essential that standard methods be adopted without delay.

Since the article in this number was written, information has been received from Mr. A. L. Armstrong in regard to one case of mandarins which was sent to him through the firm of Messrs. Turners & Growers Ltd., Auckland. Owing to various causes the fruit was not delivered for a period of five weeks after its arrival and during this time it was kept in cool storage. On opening the case the contents were found to be in excellent condition and only three out of a total of 100 were uneatable. The remainder were of a uniform golden colour and quite firm. The fruit was juicy, not shrunken, and generally quite sweet, although a few were slightly acid. This interesting record emphasises the excellent carrying and keeping qualities of Fiji mandarins when they are handled and packed in a proper manner.

COPRA.

Copra prices continue to be low, although signs of improvement in the market are evident. The necessity for reducing production costs and improving the quality of the product by the practice of better methods of preparation is more evident during times such as these than, perhaps, when the demand for copra is good and prices high. In an article published in this number an endeavour has been made to outline the history of attempts to introduce copra grading in Fiji and to urge the desirability of the early

introduction of such a system. It is desired to place on record a note of appreciation of the valuable help and advice received from the Imperial Institute, London, and from the London Copra Association, as well as for the keen and active interest taken in this subject by the Coconut Planters' Union Ltd. of Fiji.

RAT CONTROL.

Investigations into this important problem have been continued and correspondence with the Imperial Institute, London, is now published for the information of those interested. The peculiar nature of the greatest difficulty attendant upon any scheme for rat control in coconut plantations in Fiji—the habit of the rodents which in many instances live permanently in the trees—makes a satisfactory solution much more difficult. It is clear that no reliance can be placed on viruses, which are indeed definitely condemned by many authorities; not only because of their limited success, but of the danger to the health of man. It appears that rats are the cause of considerable damage in pineapple plantations. In such cases the use of baits containing red squill powder should be found effective. In addition to the use of thin zinc sheets nailed round the trunk of the trees, the possibility of employing a band of tanglefoot mixture in a similar manner has been suggested as a possible control in coconut plantations. Observers, however, state that in some parts of the Colony the rats rarely, if ever, descend from the trees. In one instance where a coconut tree was cut down, no less than 80 rats, which endeavoured to escape from the crown, were killed. It seems clear, therefore, that in addition to other methods some means of laying poison baits in the crown will have to be found. The question continues to receive close attention.

AGRICULTURAL CONFERENCE.

It has been decided to hold an Agricultural Conference again during Show Week in Suva. By the courtesy of the Municipal Council the Town Hall has been made available for this purpose. It is proposed to open the proceedings at 2.15 p.m. on Tuesday, 13th October, 1931, when it is hoped that His Excellency the Governor will preside and address the Conference. The Organising Committee has decided that the following subjects will be dealt with at the Conference:—"The Citrus Export Industry"; "Production and Marketing of Supplementary Crops"; "The Stock Industry with reference to the Export of Chilled Beef"; "Some Problems of the Banana Industry"; and "The Pineapple Industry." Gentlemen prominently connected with these aspects of agriculture have been asked to deliver addresses, after which the subjects will be open for general discussion. Notices giving full details of the Conference arrangements will be published in the local press.

The Committee formed for the purpose of organising an Agricultural Convention has continued its inquiries and approved of draft rules for submission to the first meeting which it is hoped to hold during Show Week in conjunction with the Conference. The proposals are briefly, that the Convention should be a central body representative of the various Agricultural and allied Associations in the Colony, each of which would appoint two members to the Convention. The object is to provide a central authoritative body which can advise Government on agricultural matters raised by the various participating Associations and, generally to help the development of agriculture in the country districts of the Colony. The various Progress and other Associations in Fiji are being communicated with and it is hoped that they will all approve of the formation of this Convention and agree to become participating bodies.

CITRUS EXPORTS—EXPERIMENTAL SHIPMENTS.

By A. C. BARNES, Director of Agriculture.

THE citrus industry of Fiji is worthy of more careful attention on the part of both growers and exporters than it has hitherto received. Though there are no citrus plantations of any note in the Colony there are numerous blocks each of a few trees which yield excellent fruit, and which, if cared for, would become a profitable source of income to owners. At least one person recognises the possibility of establishing a plantation of trees of selected varieties of oranges and grapefruit. In the Sigatoka district a small area has already been planted and gives promise of returning a profit to the owner.

2. Citrus fruits, that is to say, oranges and mandarins, have long formed an important section of the minor produce exports of the Colony, but the business has been badly organised, and carried on with almost an entire neglect of the most elementary precautions necessary to ensure that the fruit reaches the market in a saleable condition. That any market at all exists indicates that the fruit is of good flavour and of inherent qualities which commend it to the consumer.

3. The markets available to Fiji are good. The fruit can be exported at a time when Californian, Australian, Tahitian and Norfolk Island oranges are unobtainable. With the exercise of care during all the stages of harvesting and preparation for the market, the fruit of Fiji can command a pre-eminent position in the market of New Zealand during April and May, and in Vancouver during May, June and July.

4. It is, perhaps, unfortunate that the need for attention to this valuable asset should have come to the fore at a time of difficulty which has faced the major industries of the Colony. Unfortunate in so far that the very difficulty of low market prices may deter many from giving the attention to a commodity which has hitherto been regarded purely as a side-line, almost but not quite unworthy of serious attention.

5. Nothing beyond the most cursory examination is necessary to point out the faults of present methods of handling the citrus crop. The fruit is dashed from the trees, thrown into boxes and transported to Suva, where much to the annoyance of the exporter it has to undergo a quarantine of seven days in fly-proof storage, after which it is examined, culled and "packed" under Government supervision. Though the rejection of fruit showing signs of fruit-fly is ruthless, the packing is in most instances nothing more than throwing the fruit into banana cases, and nailing down the lids. The amusement of those in other countries who regard the citrus export business seriously and who take every precaution to ensure that their fruit reaches the market in prime condition can be imagined!

6. From the moment the fruit leaves the tree in Fiji to the time it reaches the consumer it is exposed to every possible form of mal-treatment and the wonder is that any reaches the market in eatable condition. As it is, the losses are heavy and the financial returns far lower than the industry should command.

7. The existence of a small plantation of Mediterranean varieties of orange and of mandarins at Nasinu made it possible to secure sufficient supplies of fruit under control conditions to make experimental shipments to New Zealand during the season which has just closed. The area in question had been neglected for some nine years and late in 1929 the dense undergrowth was cleared, the land cultivated and the trees pruned of superabundant growth. A small crop was obtained in 1930 but it was not until this year that the trees attained anything approaching normal bearing.

As it was the fruit during its early stages of development suffered from the strong winds and storms of November, 1930, and February-March, 1931. The trees survived the severe buffeting in a wonderful manner and most of the fruit was of excellent quality.

8. Although it can hardly be claimed that standard modern methods were adopted for the harvesting and handling of the fruit, every care was taken to ensure that the minimum of damage occurred from the time of removal from the tree until it reached the consuming market. The fruit was cut with a portion of the stalk attached and a second cut was given after the removal from the tree so that the stalk did not protrude beyond the button. Harvesting took place during dry weather and commenced about the middle of the morning when the surface of the fruit was free from surplus moisture. The oranges were loosely packed in banana cases and immediately transported to Suva by lorry. The danger of bruising during transport was reduced as far as possible by placing the boxes on a thick layer of grass and the driver was instructed to proceed slowly over rough portions of the road.

9. On arrival at Suva the cases were stacked clear of the floor and with ample ventilation space between them in a small well-ventilated concrete insectary where they underwent seven days' quarantine required by New Zealand regulations. During a portion of this time they were treated with ethylene gas in order to stimulate the development of the orange colour of the skin and so to enhance the appearance of the fruit. The method adopted was to introduce a charge of the gas giving a concentration of approximately one part in two thousand, the room being completely closed. After a period of four hours the room was ventilated by means of fans after the doors had been opened. Fly-proof screening was kept over all apertures so that the quarantine should not be in any way affected. Ventilation was continued for at least 12 hours, after which a further charge, followed by another ventilation was given. On the occasion of the first shipment three charges of gas were introduced, but for subsequent shipments two were found sufficient to give a satisfactory degree of colouring.

10. As no proper packing-house arrangements were available the culling and sizing of the fruit was carried on in as simple a manner as possible. All fruit exhibiting signs of fruit-fly, bruising, or skin damage were discarded and the remainder passed through a locally-constructed sizing machine which consisted of two tapering rollers set on a slant above a series of canvas bottomed shoots. The rollers were rotated in opposite directions, so that their surfaces travelled upwards and outwards, by means of an electric motor working through reduction pulleys. It was found that the machine was capable of sizing upwards of 50 cases of fruit per hour.

11. The fruits were then wrapped individually in white cap paper cut to the sizes required and packed in accordance with their sizes in cases of South African pattern. The arrangement of the fruits in the case was decided by their sizes and was carried on as indicated by packing diagrams which had been supplied from South Africa. The boxes used were made by Messrs. Marlows Limited of planed Kauvula timber. The wood was unseasoned and the cases were therefore piled with ample ventilation between them in an open shed for a few days before they were used. They were constructed as nearly as possible to the specification set out on page eight of the *Agricultural Journal* No. 1 of 1930, except that no cleats were used. Cases for mandarins were of 26 in. by 12 in. and 4½ in. deep outside measurement. Each case was branded with a Fijian head in black and marked in red with the number of fruits it contained.

12. Four shipments of fruit were made in all comprising oranges and mandarins from Nasinu, a small quantity of limes from Beqa and seedless limes and oranges from Taveuni. Details of two of these shipments will be found in the appendix.

13. The shipment of May 5th comprised ten cases of oranges and one case of limes. The market report stated that the shipment was a vast improvement on the bulk of oranges sent from Fiji. The price realised averaged approximately 4s. per case more than ordinary lines. In this connection it should be noted that the cases used were of smaller capacity than those normally employed, so that the difference in price was even greater than 4s. in favour of the Departmental consignment. In regard to the limes it was stated that there was no great demand, but a small trade of from 20 to 50 cases a month throughout the year could be worked up. The gross return in respect of the oranges was £8 7s. 3d., an average of 16s. 8·7d. per case, from which must be deducted transport, packing, freight, commission, wharfage and cartage, amounting to 7s. 8d. per case, leaving a nett return at the plantation of 9s. per case. The average number of fruit per case was 207.

14. Fourteen cases of oranges treated in a similar manner were shipped on May 23rd. Results from this consignment were disappointing owing to the fact that it arrived immediately after a very large shipment from Rarotonga. The return after paying freight, wharfage, cartage and commission was only £1 11s. 7d. out of which the cost of cases, transport and packing had to be met.

15. On the 4th June, 27 cases of mandarins were forwarded to Auckland. The number of fruits per case varied from 64 to 120 according to the size. The cases used were as described in paragraph 11. The consignees reported that the condition of the fruit was excellent, as was also the colour and quality. They said that the market was not strong owing to the arrival of large quantities of Australian fruit which was being sold at low prices. The returns, however, were excellent. The fruit sold at prices ranging from 8s. to 12s. 6d. per case. The total amount realised was £13 19s. 6d., an average gross return of 9s. 7·6d. per case. Transport, cases, freight, wharfage and commission cost 4s. 6·74d. per case giving a nett return averaging 5s. 0·84d. per case on the plantation. The average number of fruit per case was 88, so that the value of the fruit on the plantation after removal from the trees was 7d. each.

16. The final shipment was made on the 12th June and consisted of nine cases of oranges and two cases of seedless limes from Taveuni, with four cases of oranges and 18 cases of mandarins from Nasinu. The Firm to whom these were consigned reported that the oranges had been perfectly packed, but that the fruit had been somewhat spoiled in fumigation. The prices obtained were low owing to the simultaneous arrival of Cook Island fruit. The mandarins arrived in good order but again the market was overstocked owing to heavy consignments arriving from Sydney. The consignees stated that the fruit itself compared favourably with Australian fruit and would bring remunerative prices if it could be placed on the market earlier in the season. This statement was supported by the returns for the former shipment of mandarins already referred to. The report said that the demand for limes is assured as soon as the fruit becomes better known.

17. In spite of the depressing tone of the report the account sales were quite satisfactory considering the season and the condition of the oranges.

These were known to have been left on the trees rather too long and this fact, coupled with the time that elapsed between harvesting and shipment, would fully account for the statement that they appeared to have been spoiled during fumigation. The object was to test the possibility of profitable marketing of fruit from more distant parts of the Group and the trial indicated clearly that in future seasons earlier harvesting combined with careful handling and packing would ensure profitable returns.

18. The gross return for the nine cases of oranges was £4 4s., an average of 9s. 4d. per case. Freight, Suva-Auckland, commission, &c., cost 35s. 4d., and cases 15s., while freight, Taveuni-Suva, was 12s. 9d. Other costs amounting to 4s. 10d. were incurred for cartage from Suva wharf to the packing-shed and return and for wrapping paper, of which 3s. 3d. would have been saved had it not been necessary to quarantine, size and pack at Suva. The total charges were £3 7s. 4d., leaving a balance of 16s. 8d for nine cases on the plantation, or 19s. 11d. were the avoidable Suva charges omitted. Under normal circumstances the freight from Taveuni for a commercial consignment would have been less and the cost of extra handling in Suva unnecessary. The net return on the plantation in Taveuni for limes was 11s. 10d. for two cases.

19. From a commercial point of view such a small shipment would be unattractive to the producer, but the trial demonstrated that fruit of this class could be successfully exported from more distant parts of the Group, if proper arrangements for quarantine and packing were made at or near the districts where it was grown.

20. The oranges and mandarins grown at Nasinu and exported on this occasion gave better returns because of the lower internal charges, and though the result was not so satisfactory as with earlier shipments, oranges returned an average of 3s. 3d. per case and mandarins 1s. 8d. per case at the plantation. Oranges averaged 237 fruits per case and mandarins 103.

21. During the period covered by these trials, correspondence regarding the quality of Fiji citrus fruit passed between the Department and the Auckland Fruit Importers' Association. The latter organisation called attention to the shipment of sour fruit from Fiji and remarked on the low prices obtained for it. It was pointed out that oranges from the Cook Islands were required to conform to a standard sugar content.

22. This aspect of the citrus export business is one which receives attention in most countries where the fruit is grown. It is to the interest of the grower and exporter to ensure that fruit is of marketable quality, or in other words of the nature substance and quality demanded by the purchaser. The desire to get fruit on to the New Zealand market early in the season has encouraged those engaged in the trade in Fiji to ship immature fruit, whereby they have in many cases spoiled their market for consignments of better quality.

23. It is possible by a simple test to ascertain whether oranges are sufficiently ripe, that is whether the juice contains the proportion of sugar to acid which commends the flavour to the consumer. To endeavour to foist fruit which is not of prime quality on the market is to say the least unwise; but the practice has in the past been not uncommon and regulations have been introduced in other countries to prevent it. In Australia the danger is realised and in recent recommendations of the Citrus Preservation Committee (2) it is stated that "the harmful effect on the trade would be very great if sour or immature oranges were included."

24. The trial shipments of the past season have indicated that a good seasonal market exists in New Zealand for properly packed Fiji oranges and mandarins of good quality. It appears risky to ship to New Zealand after the middle of May owing to the supplies of fruit forthcoming from other South Pacific Islands, but from that time to the end of the Fiji season there appear to be good prospects of profitable marketing in Vancouver. Fiji fruit of excellent quality could be placed in that market before Australian supplies begin to arrive. Enquiries are being pursued in Vancouver with the object of arranging trial shipments in 1932.

25. The trials demonstrated forcibly that there is a keen demand in New Zealand for citrus fruit of good quality, attractively packed and that proper attention to the handling of the citrus crop of Fiji would lead to profitable returns. The conditions imposed by New Zealand render it necessary, as has been pointed out, to keep the fruit in fly-proof quarantine for a period of seven days prior to shipment. Not only is any attack of fruit-fly evident after this period but skin damage occasioned by rough handling shows up distinctly. Were it not for the fact that the time elapsing between shipment and consumption is short, little if any of the Fiji citrus fruit would reach its market in consumable condition. As it is the wastage is abnormally high and the price correspondingly low.

26. The most convenient spot to impose the quarantine is near the Suva wharf and it would be a simple and comparatively inexpensive matter to provide equipment for the sizing, wrapping and packing at that point. The additional expense to shippers would be small as the only extras involved are the cost of the wrapping paper, a little additional labour for proper packing, and a small extra charge for cases of better quality. As it is the whole of the fruit has to be inspected individually at the expiration of the quarantine period and packed under Government supervision. Very little organisation would be necessary to provide for sizing, wrapping and packing by standard methods.

27. So far, then, as arrangements at the port of shipment are concerned the problem is simple of solution, but more difficulty will be experienced in securing the necessary degree of care in harvesting and transport to Suva. These difficulties, however, must be overcome if the industry is to become prosperous and exporters must co-operate with producers to ensure that the necessary care is taken at all stages of the handling of the crop. The cost of the clippers required for harvesting the fruit is small and growers can themselves construct pyramidal ladders for use during harvesting operations in order to avoid damage to the trees. Picking bags are used in many countries, but in Australia the use of a packing-box of a capacity of about half a bushel is recommended. The box should be well padded inside and fitted with straps for hanging across the shoulders.

28. Quoting from recommendations by the Citrus Preservation Committee (2):—

(vii) Care should be taken to see that the fruit is not dropped, but transferred from one receptacle to another with the same care as would be given to eggs. If any orange is accidentally dropped or mishandled in any way during the operation, it should be immediately rejected, as otherwise it may be the means of ruining a whole case of fruit.

(viii) The most suitable type of field box is the box used in the canning industry, namely, a kerosene case cut open on the side with cleats nailed to each end for ease of handling. (Locally, the

ordinary banana case forms a suitable field box and has the additional advantage of being suitable for the carriage of the fruit to Suva).

- (ix) Care should be taken to see that the field boxes have no inner surface projections of any kind; there should be no nails, protrusions of wood or sharp knot holes, all of which are liable to cause injury to the rind.

29. During transport from the place where the fruit is grown to Suva every care must be taken to avoid shaking the boxes and thus damaging the fruit. At no stage should they be roughly handled. The little extra care will ensure that the oranges are not bruised and will result in considerably less wastage.

30. In countries where the citrus export industry is highly organised even more care is taken than has been indicated in the foregoing remarks. Gloves are required to be worn during the operations of harvesting and packing as it has been found that the slightest scratching on the skin, particularly that caused by the finger nail of a worker, gives rise to infection which results in rotting and loss of fruit. It is however, possible to introduce simple methods which can be gradually developed to that pitch of efficiency which will place Fiji in the position it deserves as a citrus exporting country. It is necessary that all interested in the industry should work together and obey closely any instructions or regulations which may be issued.

APPENDIX.

DETAILS OF SHIPMENTS.

1—SHIPMENT OF MAY 6TH, 1931.

Total—10 cases oranges, 1 case limes.

No. of cases.	Size.	Average diameter. (inches.)	Number of fruits per case.
1	2	2½	252
2	3	2-9/16	226
4	4	2¾	200
1	5	2 7/8	176
1	Mixed 2 & 6	2½ & 3	232
1	Mixed	..	165

Account Sales—Oranges.

1 at 18/9	£0 18 9
1 at 17/6	0 17 6
1 at 16/-	0 16 0
2 at 15/-	1 10 0
5 at 17/-	4 5 0
	<hr/>
	£8 7 3

Average gross return per case oranges .. 16s. 8-7d.

Charges per Case.

	s.	d.
Cost of case	1	8
Cartage from Nasinu to Suva	1	4-35
Cartage store to wharf	0	2-18
Freight	2	10
Wharfage & cartage Auckland	0	5
Commission	1	3
	<hr/>	
	7s.	8-53d.

Net return at plantation £0 9 0

Note.—Cost of wrapping and packing excluded.

is carefully gone over and repacked, when it is generally possible to detect the infected fruits and discard them. This detection of the breakdown of the tissues is more difficult in thick skinned grapefruits and in loose skinned mandarins, the skin of which does not come into close contact with the diseased tissues. For this reason planters, contemplating an export business, should only grow grafted fruit and should select a tight skinned variety for this purpose.

When commercial orchards are established it will be possible to do much to reduce the incidence of this pest:—

- (a) by the *prompt* collection and destruction of all fruits showing signs of attack;
- (b) by destroying any trees in the neighbourhood which act as a "carry over" for the fly between the citrus cropping seasons;
- (c) it is probable that poison baits or sprays will also be found useful, but this will only be so when the trees are grown under orchard conditions.

(2) *Fruit piercing moth Ophideres fullonica*.—Much of the damage erroneously assigned to fruit-fly is really due to punctures made by an adult moth, *Ophideres fullonica*. This moth is capable of piercing the skin of ripe oranges, bananas, &c., and feeding upon the juice. The breakdown, thus caused, shows as a circular spot, generally about half an inch in diameter as contrasted to the irregular breakdown of the fruit-fly rot. In both cases the fruit yellows prematurely, generally with an orange tint and falls to the ground. There was an enormous amount of damage due to this moth this year on Taveuni.

The adult moth has an expanse of wings of nearly four inches, the front pair being beautifully marbled in greenish brown whilst the hind wings (only visible in flight) are bright yellow banded black.

The larva of the moth is a most striking creature, velvety black with white, red and blue markings and feeds upon the *Draca* tree (*Erythrina* s.p.).

Control.—This is difficult. Destruction of all *Erythrina* trees in the district is essential. The moth occurs everywhere to India and should commercial orchards be established it might be possible to obtain some additional biological control to that already present in the country. In South Africa similar damage is done by different species of moths and the following method, recommended by Brain, should also be suitable for Fiji:—

- (a) 1½ oz. arsenate of lead powder, 53 oz. (½ gall.) treacle, 4 gallons water; or
- (b) ½ oz. arsenate of soda, 53 oz. (½ gall.) treacle, 4 gallons water.

Kerosene tins are partly filled with ripe fruit juice and some of one of the above poison mixtures is poured over them. A tin is then hung under every fifth or sixth fruit tree. If a ripe orange is cut in half and placed on the mixture, pulp side up, it is more attractive. Add to the mixture as it evaporates, and remove dead moths.

Mites.—In the Cook Islands, but much less frequently in Fiji, oranges in ripening assume a brownish scabbed appearance. This is due to attacks by a mite (*Eriophyes (Phytoptus) oleivorus*). Such fruit is generally very sweet and in the New Zealand market frequently selected for this reason.

A METHOD OF CONTROL FOR BANANA BORER
(*Cosmopolites sordidus*).

By H. W. SIMMONDS, Government Entomologist.

FOR many years entomologists in various parts of the tropics have given much thought and work in an endeavour to discover some method of controlling this beetle, but with little success, the use of the soil fumigant paradichlorobenzene, being the only method showing promise of practical result.

In Fiji some measure of success has been attained by biological methods. The predatory beetle *Plasius javanus*, introduced in 1913 by Jepson, has become thoroughly established and is undoubtedly doing good.

Nevertheless, the borer remained the most serious of the banana problems in this country as it was established in all parts of the Group and it was impossible to adopt the method used in some portions of the world of obtaining clean plants from non-infected areas for planting-up purposes.

Experiments carried out by this Department showed that, whilst flight undoubtedly occasionally occurred, it was not frequent and was negligible as a means of spreading the pest. It was also found that spreading by crawling was not nearly so rapid as is usually thought to be the case and that clean plants placed beside plants rotten with borer would frequently remain clean at the end of twelve months.

The efforts of the Government Entomologist were therefore concentrated upon devising a means of obtaining clean suckers for planting purposes, as it was felt that if clean plants were used on clean land it would be so long before these plants became severely affected that the grower would be enabled to take his crop and make his profit before this happened. In the efforts to attain this object a considerable measure of success has been attained.

Method of attack and effect of the banana borer.—The banana borer (*Cosmopolites sordidus*) lays its eggs just inside the corm of the plant, about the level of the surface of the soil, the eggs being thus most difficult to discover. These eggs hatch within about ten days and the resulting grub bores into the interior of the corm which is often completely tunnelled and rotten with the borings. When the grub is full-fed it approaches the surface of the corm, still remaining inside, where it pupates and, upon completion of its metamorphosis, eats its way out.

The effects of these attacks are twofold—

- (1) A considerably reduced bunch of fruit, the plant producing only six or eight hands instead of the proper ten or twelve;
- (2) a greatly shortened life to the estate, which gives the appearance of being worked out after $2\frac{1}{2}$ or 3 years, instead of lasting in full bearing for five or seven years.

Control.—As the insect lives throughout its earlier stages within the tissues of the corm, with only the minutest connection with the outside air, ordinary fumigating processes are useless. It was, however, thought that the fumigant might be carried into the tunnels by means of a vacuum and tests were carried out, using carbon-di-sulphide as the poison. Some measure of success was attained, but some of the full-fed larvæ and pupæ survived to a point where the plant was killed and it is doubtful if the eggs were affected.

Experiments were then carried out with prolonged soaking and the desired 100 per cent. mortality of borer and eggs was attained by the following method:—

DIRECTIONS.

(1) Good strong suckers must be selected, having one or more undeveloped lateral eyes in addition to the aerial stem.

(2) These suckers are placed in a tub, punt or other water-tight vessel, with the aerial stem upwards.

(3) They are then covered with fresh water to a depth of about two inches above the point where the stem joins the corm, leaving the aerial stem fully exposed to the air and light.

(4) They are left for 21 days, taking care that the water is maintained during the whole of that period at the same level. This is most important.

(5) After 21 days they are removed and planted out, either in an isolated nursery or in the field.

It will then be found that they die back to the corm and one of the lateral eyes develops, producing in 12 months a bigger and better bunch than would have been the result had the sucker itself grown.

Planters are strongly urged to adopt the above methods either individually or collectively by making nurseries and distributing the resulting plants.

RAT CONTROL IN COCONUT PLANTATIONS.

425/31.

Department of Agriculture, Suva, Fiji,
9th March, 1931.

Dear Sir,

I have the honour to seek your co-operation and assistance in dealing with the serious local problem of rat control in coconut plantations. The depredations of the rat are by no means confined to coconuts, but in Fiji it is found that its effect is most marked in relation to copra production and that the annual loss is of the order of 7 per cent. of the crop ("Early Nutfall from Coconut Palms in Fiji," by T. H. C. Taylor, B.Sc. (Lond.)).

2. The rodents live in the trees and appear to confine their activities to particular groups of trees in a plantation. Surridge has investigated the problem and has suggested remedial measures which are given in the *Fiji Agricultural Journal* No. 3 of 1930.

3. The use of a virus has been advocated and I observe that a new rat virus prepared by the Pasteur Institute, Paris, has been put on the market. Local opinions differ as to the advisability of introducing this or any other virus to Fiji. The Chief Medical Officer and the Senior Veterinary Officer do not support its introduction.

4. Attempts have been made to control the pest by predacious birds and animals. There are local owls which are said to feed their young exclusively on rats and something might be done to increase their numbers by providing special breeding places. This work could only be done by an expert.

5. The masked owl was imported from Tasmania in 1929, but owing to the sudden attack of those introduced upon young farm-yard birds as soon as they were liberated, the move was not popular, and nothing is known as yet of the effects of those eventually set free in a coconut plantation.

6. The mongoose was also introduced, with the object of controlling rats in sugar-cane areas, but local legislation prohibits its introduction to other islands in the Group and popular opinion is averse to any lifting of the ban.

7. There is an undoubted lack of co-operative effort on the part of owners of coconut plantations and the problem is a proper one for the Coconut Committee of Fiji to deal with on similar lines to the methods adopted for the control of disease and loss occasioned by insects. The Committee has given much attention to the matter, and at a later date may be able to engage a special officer to inaugurate an organised campaign in somewhat the same way as was done in Cyprus.

8. I should, therefore, be grateful for your advice on the following points:—

- (a) the use of viruses; those recommended; objection, if any, to their employment;
- (b) the possible introduction of other means of control than those already tried locally;
- (c) the prospects of securing the services of an experienced man, capable of organising a rat-control campaign in Fiji.

9. I forward for your information copies of Departmental publications on the subject.

I have, &c.,

The Director, Imperial Institute,
Kensington, London, S.W.

DIRECTOR OF AGRICULTURE.

Imperial Institute, South Kensington, London, S.W. 7,
19th May, 1931.

Sir,

In reply to your letter 425/31 of 9th March I have pleasure in forwarding you the following information on rat destruction, with special reference to the points you have raised.

Rats do much damage to tree crops in many parts of the tropics, but as they do not usually live in the trees they can often be dealt with fairly effectively by well-known methods, such as the use of poisons and traps, and also by introducing carbon bisulphide, sulphur dioxide, &c., into their burrows.

The special difficulty due to the rats spending all or most of their time actually in the trees appears to be largely confined to your region of the world.

In Papua (see *Bulletin* No. 8, 1918, of the Department of Agriculture) trouble resulting from this habit of life is reported. It was apparently not very serious at the date mentioned and poisoning with white arsenic proved usually satisfactory. The poison was dusted on the cut surfaces of sweet potatoes, ripe bananas, or sugar-cane joints, cut lengthwise and the parts skewered together again.

In Fanning Island, according to an inquiry received this year at the Imperial Institute, the problem is evidently very similar to yours. A great deal of damage is done by rats which seldom or never come to ground and no satisfactory method of dealing with them has yet been found.

In French Oceania rats inhabiting coconut palms are also a very serious pest. The most satisfactory method found there for preventing their

ravages has been banding the trees with sheet zinc. In *Bulletin des Matieres Grasses de l'Institut Colonial*, 1928, No. 4, 118-130, and 1929, No. 10, 316-17, an account is given of the action taken by the Government to arrange for the importation of very large numbers of sheets of zinc. Such work would of course have to be undertaken in a systematic manner, isolated blocks of trees being banded and then the rats dislodged from their crowns. By the use of zinc sheets the difficulty due to galvanized iron or tin bands becoming rusty, as mentioned in your *Agricultural Circular V*, No. 2, would be avoided.

You could doubtless obtain later information on the progress and success or otherwise of the scheme from the *Chambre d'Agriculture des Etablissements Francais de l'Oceanie*.

On the question of viruses the best authoritative opinion obtainable is definitely against their use.

I enclose copies of a letter, memorandum and leaflet received from the Ministry of Agriculture and Fisheries. In the first it is stated that "the Ministry does not recommend the use of virus preparations for rat destruction. Its attention has been drawn to the reported discovery of a new rat virus by the Pasteur Institute, but as a result of inquiries which have been made in connection therewith the Ministry can see no reason to depart from the opinion referred to in the leaflet."

The United States Department of Agriculture holds a similar view on the use of viruses, as indicated by the following extract from the new edition of their *Farmers' Bulletin* No. 1533 on "Rat Control" issued June, 1930:—

"Rat viruses on the American market contain living organisms, or bacteria, known as the Danysz bacillus, which when ingested by rats is said to cause a disease that is followed by great mortality. In extensive experiments with rats conducted by bacteriologists of the Department of Agriculture, however, even the most virulent cultures failed to produce a high percentage of deaths, while the majority of the viruses tested were practically ineffective. Also the disease produced was found not to be contagious, except when one rat ate another. Thus there is little probability of the disease spreading to an appreciable extent. There also appears to be well-founded doubt as to the harmlessness of rat viruses. The Danysz bacillus belongs to the same group as the food poisoning bacilli and is indistinguishable from them. Although it has not been possible directly to trace many cases of human food poisoning to rat viruses, two State boards of health have prohibited their sale within the States. For these reasons the department does not recommend the use of viruses for the destruction of rats."

Your question in regard to securing the services of an experienced man capable of organizing a rat control campaign is answered in the enclosed letter from the Ministry of Agriculture. Application was made to the Ministry as the latter had arranged for the Cyprus Government to obtain the services of such an officer.

I am, &c.,

The Director of Agriculture,
Suva, Fiji.

S. E. CHANDLER,
for the Director.

MEMORANDUM ON THE USE OF VIRUSES FOR THE DESTRUCTION OF RATS.

(Prepared by the Ministry of Agriculture and Fisheries.)

1. It has been the consistent policy of the Ministry of Agriculture and Fisheries not to recognise officially the use of viruses consisting of cultures of microbes causing intestinal diseases for the destruction of rats and mice. The position is explained in the Ministry's Leaflet No. 244, page 7, a copy of which is attached.

In connection with the experiments conducted by the Zoological Society of London on behalf of this Ministry and the Ministry of Health in 1919 with a view to ascertaining the most successful means of combating rats and mice, preparations of viruses were also tried and the report on their use is as follows:—

“The discovery some time back of a bacillus pathogenic to rodents led to a new method for the destruction of rats and mice. Following this discovery, the virulence of the organism was raised by artificial methods in the laboratory and a number of rat viruses were placed on the market.

The manufacturers of these claimed that the bacillus was so virulent that it would kill rodents in about 10 days, and that within a month the disease would spread with fatal results to the whole of the rat (*or mouse*) population of the area under treatment. The results of recent investigation on the efficiency of some of the viruses on the market have been disappointing. Bainbridge has experimented on a very large number of rats in captivity, and the results of his experiments showed that the destructive power of all the viruses he tested was inconstant, the death-rate in the different experiments varying from 20 to 50 per cent. Further, according to this experimenter the presence of agglutinins in the serum of the rats which survived after being fed on virus gave reason to suppose that a certain proportion acquired immunity and were therefore unlikely to succumb to a second infection.

Experiments with the rat-viruses conducted some years ago during the outbreak of plague in San Francisco also gave poor results.

It must be recognised that, if generally successful, this method of exterminating rats and mice by spreading among them a disease, not affecting man and domestic animals, could not be improved upon, and I was therefore anxious to give a thorough test to all the viruses on the market in the hope that the results of the experiments under natural conditions would differ from those obtained in the laboratory.

In all seven tests were made with different virus preparations, and of these one only was an unqualified success; three were partial successes, a very slight reduction in the number of rats being recorded, and three were absolute failures. The experience of a number of reliable witnesses indicated that the successes in these cases amounted to about 33 per cent.

No further official tests have been made in this country but many reports have been received, most of which state that the results obtained by using viruses are disappointing. These may be due to conditions of temperature, immunity of rats and mice eating the baits containing the germ or to the viruses not being in a pathogenical condition owing to length of manufacture, weakness of the strain of bacillus used or contamination with moulds, or other germs. However, on the Continent a great deal of experience has been obtained.

According to Dr. Hans Wreschner in a report contained in the *Zeitschrift für Hygiene und Infektions Krankheiten*, 93 Vol., 1921, pp. 35-42, it was found that Danysz and ratin viruses, amongst others, were the cause of illnesses and deaths in human beings in Germany and Switzerland, and it is this official's opinion that such bacterial preparations should only be used away from human habitations owing to the potential danger to man and domestic animals.

In a report of June, 1924, by A. Moncke, a practical worker with viruses, it was stated that ratin had not been proved to be harmless to human beings, and that he had himself suffered from such an infection."

In the Annual Report of the Medical Officer of Health for the City of London for 1924 the following remarks were made:—

"In spite of the discouragement of its use by the Ministry of Agriculture and representations to the Government by the City Corporation, rat virus is still being largely used in many premises. The experiences gained in the City does not bear out the claim that rats and mice die in the open after being poisoned by virus, as complaints have been made of the nuisance of dead rats between match-boarding and walls and under floors in premises where virus has been used.

By a general Army Order, dated July 29th, 1919, the use of any vermin-destroying virus preparation is prohibited in all military establishment and camps, the reasons stated for their prohibition being (1) they are apt to produce a rat population which is immune to the action of the virus, (2) there is a certain degree of risk of food contamination, with resultant food-poisoning outbreaks.

Experience in the City has proved that both these reasons are sound. It is regrettable that the civilian population is not afforded the same protection from food poisoning outbreaks as that which the Military Authorities afford the Army by prohibiting the use of virus. It probably kills only 50 to 60 per cent. of the rats and should be condemned for that reason alone."

Some short time ago I drew the attention of a firm of food manufacturers in this country to the question of discontinuing the use of virus on their premises. They had obtained the virus from Holland, and the Ministry of Health in this country reported as follows:—

"The material yielded a profuse growth of *B. enteritidis* (Gaertner); this organism may be pathogenic for human beings and domestic animals.

This Department do not regard with favour the use of these viruses as they are attendant with a risk to human health.

The organism invariably employed is one of the food-poisoning group and infected rats recovering from the illness may retain these organisms in their intestines for long periods, with the possibility of contaminating human food with an infection which is highly pathogenic."

It is understood that the use of this virus has now been discontinued both in the English and the Dutch factories.

The following is an extract from the Annual Report for 1925 of the Surgeon-General of the U.S.A. dealing with plague suppressive measures in Oakland, California:—

"Moreover, the results of trappings are definite, whereas poisoning results are problematic. A biologic poison known as ratin was tried, but the opinion formed was that poisoning was of no great

value. Better results, however, were obtained with ratin— a preparation of squill and it seemed evident that poisoning by squill was of distinct value.

At least two of the commercial firms engaged in marketing so-called "rat viruses" that are claimed to create an epizootic gastro-enteritis in rodent population, advocate and practice a system of double poisoning, the first by a virus and second by a chemical poison. It seems pertinent to suggest at this time that whatever values these systems possess is probably due to the chemical poison, not to the virus, and that the former could be used as effectively and much more cheaply under their correct designation rather than as a proprietary product."

2. The use of a virus on an extensive scale is undoubtedly much more expensive than the application of safe poisons or even dangerous poisons. If the circumstances permit, gassing is a comparatively cheap way of destroying rats, especially if labour is inexpensive. It is difficult to give exact figures, but some years ago a campaign was organized in the City of Birmingham and some hundreds of pounds were spent in applying Liverpool virus. A subsequent application of a bait containing barium carbonate was said to have been quite as, if not more, efficacious than the use of virus and the cost was many times less. A leaflet (D.R.I.) giving notes for the guidance of officers appointed to supervise measures for the destruction of rats and mice is attached.

The danger to domestic and undomestic animals has been briefly dealt with under 1. In this country and on the Continent rodents other than rats and mice have been affected by the use of viruses and it has been stated that the domestic animals have also suffered. Above all the use of a disease spreading rat poison should be only pathogenic to rats and mice. All preparations I have had to deal with hitherto do not conform to this standard. In addition immunity plays a dominant role in the question of destruction and nearly all makers of virus supplement their bacterial preparation with a secondary one, invariably a red squill preparation in order to obtain 100 per cent. kill. This is not logical, because if the secondary preparation is necessary to obtain 100 per cent. kill it should be used in the first instance as advocated by this Ministry and not to patch up the fallacies of the virus application. It must be admitted that if conditions are favourable and expense is no object the use of a virus will weaken the strain of rats and make them more susceptible to the use of a secondary preparation, but this is more a matter of theory than of practical rat destruction.

EXTRACT FROM "NATURE," APRIL 4, 1931, PAGE 532.

The value of red squill powder in the destruction of rats is becoming increasingly recognised. When experiments were carried out in the Zoological Gardens in London some years ago, it was found that the liquid preparation of red squill (a liliaceous plant known also as scilla and sea-onion, *Urginea maritima*) was more trustworthy than powder mixtures. Since 1923, however, the United States Department of Agriculture has been experimenting with the powdered forms, and it has been found that a powder of maximum toxicity can be obtained by drying the sliced bulbs at a constant temperature of 80 degrees C. Thus the greatest difficulty in the use of red squill, irregularity of results, has been overcome, and the poison has become the most widely used against rats in the United States. It is greatly in its favour that this rat poison is relatively harmless to human beings and

domestic animals; indeed, in field tests, prairie dogs and pocket gophers refused to eat the red squill baits, and in most cases cats, dogs, chickens, pigeons and pigs either refused to eat poisoned foods or, having eaten, promptly vomited them. One of the authors of the new United States Department of Agriculture *Leaflet 65*, "Red Squill Powder and Rat Control," himself swallowed 15-grain and 40-grain doses of a toxic red squill powder without untoward results.

GRADING OF COPRA FOR EXPORT.

Imperial Institute, London, S.W.7,
6th March, 1931.

Sir,

With further reference to your letter No. 1300/30 of the 15th August last and in continuation of my letter of the 3rd October regarding the grading of copra for export, I have to state that the questions involved have now been fully considered by our Advisory Committee on Oils and Oilseeds, in consultation with the London Copra Association and other experts, and I send herewith a memorandum summarising the various recommendations obtained.

If further steps are taken with a view to the grading of Fiji copra, the Imperial Institute will be glad to receive as suggested in the memorandum, experimental samples of the proposed grades for submission to trade experts. We shall also be glad to be of any further assistance which may be possible.

It was hoped to send you with this memorandum a set of samples representing the usual commercial grades of copra now on the London market, which were promised by one of the firms consulted. These have not yet been received however and the memorandum is now being forwarded without them in order to avoid further delay. The samples will be despatched to you immediately they are received.

I am, &c.,

The Director of Agriculture, Fiji.

HAROLD BROWN,
for Director.

THE IMPROVEMENT AND GRADING OF FIJI COPRA FOR THE MARKET.

Grading.—It is considered that the grading of copra prior to export from Fiji should contribute towards the improvement of the quality of this product entering the world's market. In this connection it would be advisable to restrict the number of grades to two, the better of which would represent a quality intermediate between that of Straits and Ceylon copra. In the event of a decision to adopt grading, it is suggested that, before such grading is put into force, samples of the proposed grades should be forwarded to the Imperial Institute in order that the opinion of the trade may be obtained upon them.

Quality.—The following characteristics are considered in judging the value of copra:—

Size of pieces.—Large pieces are preferred by the trade. In small pieces the acidity of the oil tends to be higher. On the other hand, small pieces dry more rapidly and can be packed more compactly.

Thickness.—Thick copra is preferred to thin. Thinness suggests that the copra has been prepared from nuts which were under-ripe.

Colour.—The inner surface of copra should be as light-coloured as possible. It is more important, however, that the pieces internally (*i.e.*, on being cut through) should not show any discolouration.

Brittleness.—Many manufacturers prefer a brittle copra as they find such a copra gives a more satisfactory result on crushing. The drying should be controlled to prevent the copra from becoming horny through too rapid drying.

Mould and insect attack.—The presence of mould, especially of black mould, detracts from the value as does also damage by insect attack.

In the light of the above desiderata for copra of good quality, it would appear that the chief defect of the present Fiji product is its poor colour. This is possibly due to some extent, if not entirely, to lack of sufficient care in protecting the nuts from rain during the drying process or from damp during storage. Care should also be taken to use only ripe nuts, and these with advantage might be cut into quarters instead of into a large number of pieces. The drying should be so controlled that the products does not become horny or discoloured internally.

Increased price.—If the copra can be improved in quality, the best way to obtain an enhanced price for it would be to market it on type, *i.e.*, to sell consignments on sample and not merely as "Plantation Fiji" or Fiji Copra." Care would of course have to be taken in such case that the bulk consignment was equal in quality to the sample. When offered in this way there should be a greater chance of obtaining a premium over the market price of the Fiji copra at present exported. In general the minimum shipment of any new grade of copra should be from 100 to 200 tons.

If, however, the present method of marketing be followed in the case of an improved quality of Fiji copra, it is not likely that an enhanced price will be received immediately, but if the improvement is permanent and buyers become able to rely upon the maintenance of the quality, such copra may ultimately fetch a price slightly higher than that paid for the ordinary grade of Fiji copra. As was the case with Crown Estates Samoan copra (which is now selling at a slight premium) it would probably take several years for an improved grade from Fiji to receive this recognition in the market.

Conclusions.—The improvement of the quality of Fiji copra is desirable and may be effected by taking the precautions outlined above. If grading is adopted the number of grades should be restricted to two. If the quality is improved an enhanced price may eventually be obtained. Whether the increase in price will be justified by the increased cost of preparation can only be determined in Fiji but even if the increase is small the improvement in quality should lead ultimately to an extended demand for Fiji copra.

THE GRADING OF FIJI COPRA.

By A. C. BARNES, Director of Agriculture.

THE question as to whether Fiji copra should be graded or not has been under consideration for several years. The subject was referred to in the Governor's Speech to Legislative Council on the 22nd November, 1926, and a Select Committee was appointed to consider a Draft Bill to raise the standard of copra produced in the Colony and to prevent the export of inferior copra. The report of this Committee was published as Council Paper No. 4 of 1927 which includes a memorandum from Sir Maynard Hedstrom and a

Draft Bill which, with amendments to be referred to later, was ultimately passed. This Bill in its original form included provisions for the compulsory grading of copra. The Committee's report was discussed at length by the Legislative Council on the 2nd June, 1927 (reference Fiji Legislative Council *Debates* 1927, pages 90-97).

2. A motion was approved for the introduction of a Bill at a subsequent session. The Bill was read for the first time on the 17th October, 1927, and the second reading was taken on the 24th October. During the debate His Excellency the Governor stated that it was proposed to amend the title of the Bill so that it would not refer in any way to a Bill to prevent the export of inferior copra from the Colony and indicated that the Bill as proposed to the Council would not interfere with the carrying on of the export trade of copra as it then existed. It was hoped that permissive instead of compulsory grading would provide the necessary incentive, both to Europeans and to natives, gradually to improve the quality of copra so that it might be graded officially as first or second grade copra.

3. The general effect of amendments to the original Bill which caused it to be presented to Council in modified form and of amendments made during its passage through Council altered completely the effect of the Bill in so far as grading of Fiji copra is concerned. Subsequent amendments passed at later sessions of Legislative Council did not improve in any way the position regarding grading nor did Proclamations under Section 15 apply the permissive grading sections to any part of the Colony so that they may be said to have exercised no effect whatsoever on the quality of Fiji copra.

4. The Coconut Planters' Union have at all times supported the proposal to grade Fiji copra and to establish definite standards of quality. Since May, 1930, they have renewed their efforts to secure the introduction of a workable system of export inspection and grading. As Director of Agriculture I have paid close attention to this matter since my arrival in the Colony and have taken steps to secure information from the Imperial Institute regarding comparative market prices of copra from different exporting countries as well as on copra grading and the standards of quality most likely to commend themselves to the market. In a letter dated 17th April, 1930, replying to a request from me, the Director of the Imperial Institute kindly offered to furnish such information as was available and to send at regular intervals copies of market reports from Messrs. L. M. Fischel & Co. Ltd. This correspondence was published in *Agricultural Journal* No. 2 of 1930, together with copies of remarks on copra and coconut oil published in the *Trade Review* on the oil and oil-seed markets during 1929.

5. His Excellency received a deputation of the Directors of the Coconut Planters' Union Ltd. on the 4th June, 1930. The Acting Colonial Secretary and myself were present. The deputation handed to His Excellency a copy of a circular letter which had been forwarded to all members of the Union, and shippers and other persons interested in the production and export of Fiji copra. Other papers presented were a letter from the Directors, copra market reports from Messrs. L. M. Fischel & Co. Ltd., and a reprint of an article on Fiji copra by Clive Joske. The object of the deputation was to bring to the notice of His Excellency the history of attempts to introduce copra grading, the objection to the principle of voluntary grading provided for in the Copra Ordinance 1927, and the desirability of making early provision for the compulsory grading of all copra exported from Fiji. The deputation urged that the London Copra Association should be consulted

and that if and when compulsory grading were introduced that Association should select a man for the post of Inspector and Grader.

6. His Excellency ordered me to make a record of the proceedings and to prepare a memorandum for the consideration of Executive Council. In the course of the discussion the Acting Colonial Secretary said that the system of permissive grading was introduced in order to give an opportunity of demonstrating the advantages of grading to native producers, but he agreed that as no grading had yet been done the time appeared now to be ripe to consider the introduction of compulsory grading.

7. Action has been continued during the period elapsing since the date of the interview, and communications have passed between myself, the Coconut Planters' Union Ltd. and the Imperial Institute, London. That correspondence may be summarised as follows:—

(a) Letter dated 18th June, 1930, from the Director of Agriculture to the Secretary, Coconut Planters' Union Ltd., Suva, referring to the interview between His Excellency the Governor and the deputation from the Union and asking them for forms of contract for copra approved by the London Copra Association, together with information regarding the characteristics which determine the relative market values of various grades of copra and the minimum shipments of high grade copra which would command prices in accordance with their quality. The desirability of reducing storage and transport costs was urged and it was pointed out that careful methods of preparation yielded not only a product of better value but a greater amount of copra from the same quantity of raw material. Reference was made to an article on mould damage to copra in *Agricultural Journal* No. 2 of 1930.

8.—(b) Letter from the Secretary, Coconut Planters' Union Ltd., dated 21st June, 1930, formally acknowledging (a).

9.—(c) Letter from the Coconut Planters' Union Ltd. to Director of Agriculture dated 3rd July, 1930, forwarding copies of two forms of contract upon which all copra sales take place in or through London and suggesting that the Imperial Institute communicate direct with the London Copra Association in regard to matters referred to in (a). A recent market circular from L. M. Fischel & Co. Ltd. was forwarded. It was stated that at least 25 per cent. of Fiji copra was now or could easily be made of F.M.S. Straits quality as most plantations of any size were equipped with driers.

10.—(d) Letter dated 15th August, 1930, from the Director of Agriculture to the Secretary, Coconut Planters' Union Ltd., acknowledging (c) and submitting suggestions for consideration regarding the possibility of producers of good quality copra shipping their copra under distinctive marks to Suva where inspection could be made and consignments officially branded for export. It was suggested that producers of high grade copra might be registered and required to maintain the standards of quality specified for grades decided upon as a condition of registration.

11.—(e) Letter from the Director of Agriculture to the Director of the Imperial Institute dated 15th August, 1930, asking for information in regard to copra grading and standards of quality. It was suggested that the Institute should communicate direct with the London Copra Association in regard to the characteristics as judged by cursory and superficial examination which determined the relative market value of various grades of copra and the minimum shipments of good quality copra which would command higher prices.

12.—(f) Letter from the Secretary, Coconut Planters' Union Ltd., to Director of Agriculture dated 29th August, 1930, stating that no practical

advantage was likely to be gained by the system suggested in (d). It was considered that unless the principle of grading were adopted by all in Fiji, few planters would attempt to grade their copra on the estates into what they considered to be export grades. The only point at which copra grading could usefully be employed was at the port of export. It was essential that the system be a compulsory one; the salaries of the staff necessary might be provided by a levy on exported copra. Reference was made to co-operation by the Empire Marketing Board.

13.—(g) Letter from the Director of the Imperial Institute to Director of Agriculture dated 3rd October, 1930, acknowledging (e).

14.—(h) Letter from the Director of the Imperial Institute to Director of Agriculture dated 6th March, 1931, forwarding a memorandum on the matter of grading of Fiji copra for the market and referring to a set of samples representing the usual commercial grades of copra which would be despatched at a later date. The memorandum forms Appendix 1.* Copies of this letter and the memorandum were forwarded to the Directors of the Coconut Planters' Union Ltd. and to other gentlemen interested in copra production and export and their comments were invited.

15. On June 23rd, 1931, a deputation from the Coconut Planters' Union Ltd. was received by His Excellency the Governor when a memorandum was presented outlining a scheme for export copra grading. It was pointed out that the most powerful inducement to the production of first grade copra was some direct financial benefit and a graduated export tax on copra was proposed with provision for the payment of a bonus on first grade copra at the expense of the lower grades. The scheme was outlined in the memorandum as follows:—

- (1) copra to be graded at Suva and Levuka by special graders appointed through the London Copra Association;
- (2) no charge to be made for grading at Suva and Levuka (two principal export points);
- (3) exporters to be free to ship from other ports ungraded, but to be allowed to make special arrangements for grading at outside ports at their own expense. (On somewhat parallel conditions to those upon which ships are permitted to take Customs officers from Suva or Levuka and load cargo at other than ports of entry);
- (4) three grades of copra to be established with such names as "Fiji Plantation," "Fiji F.M.S.," and no name;
- (5) no export tax to be levied on copra graded as "Fiji Plantation"; "Fiji F.M.S." to pay 1 per cent., or whatever is regarded as the normal rate of tax for the time being; the unnamed copra to pay double that tax;
- (6) a bonus of 2s. 6d. per ton to be paid on all copra graded as "Fiji Plantation."

16. Messrs. L. M. Fischel & Co. Ltd's market reports have been received regularly from the Director of the Imperial Institute. In spite of the almost continuous fall in market prices to the beginning of June, 1931, those reports indicate that the higher values of Ceylon F.M.S. and Singapore F.M.S. continue to be a feature of the market. Under date 29th April, 1931, the market price of South Sea F.M.S. c.i.f. Northern European ports was £13 12s. 6d., prices for Ceylon and Singapore F.M.S. being £15 2s. 6d. and £14 2s. 6d. respectively.

17. Late in 1930 it was reported that San Francisco buyers had lost interest in copra shipped direct from Rotuma because of its inferior quality

* See pp. 70-71.

and that if early steps were not taken to deal with the situation Rotuman producers might find themselves without a market. A Firm of San Francisco importers stated definitely that their crushers were generally loath to contract for any Fiji sun-dried copra because of the extreme variation in the quality of the lots received.

18. The position now reached is that a strong body of opinion representative of producers in Fiji supports the introduction of a system of export grading of copra under marks which will indicate to the overseas purchaser the standard of quality of individual shipments. Consumers, that is to say, crushers, would welcome the opportunity of securing parcels of Fiji copra of certified quality. Local merchants in most cases, if not definitely antagonistic to export grading, appear not to be entirely in favour of it. Although merchants' interests must receive some consideration in connection with a problem of this nature it should be borne in mind that they act as the intermediary between the producer and the consumer and if both producer and consumer are in favour of compulsory fixation of standards of quality and export grading the merchants should be prepared to fall into line.

19. The present Copra Ordinance with its permissive system of grading has not had the desired effect, and to attempt to administer it in its present form in so far as its grading provisions are concerned would prove a costly and ineffective experiment. Under present circumstances the incentive to produce copra of high quality is lacking except in cases where producers make a sufficient quantity to warrant shipment under their own brand to a consumer whom they have been able to satisfy in regard to maintenance of satisfactory standards of quality of their copra. Without an established system of copra grading, purchasers of Fiji copra have to safeguard themselves against its low quality and they therefore fix the price on the basis of the worst they expect to receive. The resultant discouragement to those who would and could produce a better quality article is obvious.

20. The merchant's point of view can of course, be understood. With a system of compulsory grading of copra he would have to separate good and bad copra in his export shed, instead of mixing it as he does at present. Some trouble would be involved by the work of the Inspector who would require the withdrawal of selected bags of copra for examination. In this way a certain amount of additional handling would be necessary.

21. It is interesting to compare the attitude of local merchant firms to export produce grading with that displayed by merchant firms in other Colonies who are themselves interested not only in the actual purchase of raw produce, but in its utilisation in industry afterwards. In the case of the latter, export produce inspection is welcomed and has, in fact, been definitely pressed as a desirable means of improving standards of quality and of securing higher returns not only to the producers but to the merchant themselves. I know of no case where export produce inspection and grading has not benefited all classes of the producing and merchant communities.

22. The position in regard to copra has undergone a change during recent years. Results of scientific inquiry have been applied industrially to the needs of the edible oil and fat industries and a wider range of oils and fats can now be employed than was the case a few years ago. The effect of the competition of other oils and fats on the value of copra has been shown in a remarkable manner during the past three years and although the almost continuous fall in market prices has not been entirely occasioned by the increased employment of other oils, that has undoubtedly been a very large factor. The user of coconut oil under modern conditions would endeavour to employ the best quality product at a price which suits him and which, at

the same time, will be considerably in excess of that offered for inferior grades. He may still be prepared to purchase those inferior grades but, again at a price which suits him and at a figure which, as has been shown, is considerably below that for superior standard qualities.

23. Fiji copra has long had a bad name. Crushers have often complained about it and attempts have been made to improve the position. The copra Ordinance was originally designed to improve the quality of locally-produced copra by a system of compulsory export grading which was to be supported by the suppression of undesirable practices on the part of the copra producer. It has been shown that the Bill in its passage through Legislative Council lost its original character and that since it became law it has exercised no appreciable effect on the quality of Fiji copra. Whether the position will ever arise when inferior copra will be impossible to sell is a question that time only can answer, but events have shown that in one or two instances Fiji has been dangerously near to that state of affairs. It is reasonable to assume that the Copra Ordinance has been given a fair trial; that it has failed miserably to achieve the purpose for which it was made law; and that the time has now arrived when compulsory grading of copra should be introduced. I recommend therefore that early steps be taken to provide the necessary legislation and to establish the service required.

24. Legal power should be taken either by amendment of the existing Ordinance or by the introduction of a new Bill to empower the Governor by Proclamation to require copra exported from any port or part of the Colony to be inspected, graded and branded prior to shipment. Provision would require to be made for the appointment of Inspectors, the establishment of grades, the manner of inspection, the marking or branding of bags containing copra which had been inspected and graded, the making of regulations and penalties for breach of the Ordinance and regulations.

25. It would be desirable in the first instance to confine export copra inspection and grading to the port of Suva where the work would be under constant and close supervision. After a period, say, one year, the system could be extended to Levuka and to other points of export from the Colony. One Inspector only would be required in the first case, who would be a man of considerable experience whose appointment was approved by the London Copra Association in accordance with the recommendation of the Coconut Planters' Union Ltd. In the course of two years such a man would be able to establish the system on a satisfactory basis and to train other men who would continue the work after the conclusion of his period of engagement.

26. The cost of the service during the first two years would be about £1,700, made up of salary £700 per annum, return passages £250, and incidental expenses £50. Clerical services could be provided by the existing staff of the Agricultural Department. In the third and subsequent years the annual cost should not exceed £580—salary, say, £400 to £500 for the Inspector and Grader, and a small provision for expenses. Inspection would be carried on in exporters' sheds, while labour for the work involved would be provided by the exporter.

27. The scheme could be financed by an export tax on copra, to be administered in a manner to be decided. In this connection the scheme advanced by the Coconut Planters' Union Ltd. could be considered. A tax of 8d. per ton on all copra exported from the Colony would suffice to meet the cost of the inspection and grading service in 1932 and 1933. This would yield £833 in 1932 on an estimated output of 25,000 tons, and £1,000 in 1933 on an estimated output of 30,000 tons. In later years a tax of 4d. per ton

would be enough. A small premium above market prices for second grade copra would more than compensate producers for the cost of the service.

28. The argument will doubtless be adduced that the small premium accruing for higher grade copra will not meet the additional production costs incurred. It has been pointed out that the advantage to the producer is not so much the slightly higher market price for good quality copra, as the increased quantity that can be produced and marketed from the same amount of raw material by the practice of improved methods of preparation. This contention is supported by scientific evidence which clearly shows that incidental losses occasioned by moulds and insects are greatly reduced, with the result that returns per acre are increased and production costs thus lowered.

NOTES ON COCONUT PESTS AND NOXIOUS WEEDS IN FIJI.

By R. J. A. W. LEVER, B.Sc., A.I.C.T.A., F.E.S.

DURING the months of March and April, 1931, the author, at the suggestion of the Director of Agriculture, made a tour to Taveuni and Lau, primarily to investigate the result of two liberations of *Apanteles tirathabæ* against the spike- or spathe-borer (*Tirathaba trichogramma*) and also to study the leaf-miner (*Promecotheca reichei*).

Tirathaba trichogramma, Meyr.—Two colonies of the Javanese Braconid *Apanteles tirathabæ* were liberated at Mua, Taveuni, by Mr. T. H. C. Taylor in 1930. The first, at the end of April, consisted of 65 males and 100 females, and the second, in mid-November, of 50 of each sex. The site chosen was a block of Malayan Dwarfs planted at 15 and 20 feet quincunx-wise. During March, 1931, the writer collected several hundred *Tirathaba* larvæ from trees near the original liberation and up to a distance of a quarter of a mile, including several normal tall coconut trees. Young larvæ in the first and second instars, which are the stages parasitised by the *Apanteles*, were reared during the following week, while a number of third and fourth instars were preserved in chloral hydrate for subsequent dissections to find the internal parasite. All the young larvæ were reared through to moths, while no parasites were found on dissection.

The explanation of the non-recovery of the parasite may be due to unfavourable weather killing off the colonies which were rather small in each case (165 and 100) or, more probably, they may have spread so widely over a large area of the island that they are present in negligible numbers near the original site.

This apparent failure of *Apanteles* in Taveuni contrasts with its spread in the Suva district where there has been a noticeable reduction in the numbers of *Tirathaba* larvæ per spathe between the beginning of January and early March.

At Vuna and other districts in the south of Taveuni there were signs of an appreciable nut-fall at the end of April but no insect was incriminated.

Promecotheca reichei, Baly, (the Coconut Leaf-miner).—Statements of the damage done by this Hispid are still often inaccurate. Thus Maulik (1) states that the larvæ live in the folds of the unopened tender leaf-buds, whereas it is not until the leaves have opened that the eggs are laid and then they do not hatch for another two and a half weeks after this. Although indigenous to Fiji this beetle is rather scarce west of Taveuni and is normally a pest only in the Lau group, where the weather is very dry. The damage

is two-fold, consisting of fine lines gnawed by the adult on the undersides of the tips of the distal leaflets, and larval mines, which may be seven inches in length, between the epidermes.

Before going to Lau the writer was most generously allowed to see an unpublished paper by Mr. T. H. C. Taylor who studied this insect for six months on Vanua Balavu. The present writer was only able to visit one estate, namely, on Munia, but unfortunately the beetles were just starting to oviposit so that there were no larvæ present during the visit. The beetle is most serious after a hurricane when the leaves have already suffered badly from wind damage. It is estimated to cause a loss of from 25 to 33½ per cent of the crop by weakening the trees.

Both the egg and larvæ are parasitised, the former by a Chalcid (*Chætostrictia*) and the latter by an external Elasmus, which in turn has a hyper-parasitic Eulophid (*Tetrastichus* sp). The percentage parasitism of the larvæ in the January outbreak was about 15 at Munia, but no record could be obtained of the amount of secondary parasitism.

The most serious damage by the beetle is to the third and fourth youngest open leaves, the tips of the terminal pinnæ being especially eaten, giving a silver-grey colour to the leaves which is very characteristic. The beetle confines itself to a group of trees till these are badly injured, when it flies away to start another localised infestation. It is interesting to note that on one occasion an egg was found on the shiny dorsal surface of the leaf instead of as usual on the rougher lower side. It was seen that the damage had always spread from some site on the coast and the explanation seems to be the same as that advanced by Jepson (2) for Levuana, viz., that the coconut leaf-baskets consisting of leaves with some live pupæ in the mines were carried inwards from landing places by the natives.

Undoubtedly the chief controlling factor of this pest is not insect parasites but an abundant rainfall, as it is only in the very dry districts that it is of economic importance. In Taveuni this beetle occasionally does harm, but nothing comparable with that done in Lau. The rainfall for these two places during the visit was:—

	<i>Mua, Taveuni.</i>	<i>Munia, Lau.</i>
	<i>Inches.</i>	<i>Inches.</i>
December, 1929 ..	8.52	0.4
January, 1930 ..	12.05	8.1
February, 1930 ..	28.14	12.3
March, 1930 ..	9.1	5.9

Unfortunately the parasites are very susceptible to rain, thus nearly 37 per cent. of the *Elasmus* were found drowned in the mines at Mua. Another factor which favours the pest is wide planting of trees, as the beetle prefers sunlight and clear space rather than shade and crowding. Hence, one finds that European estates with their 30 foot planting suffer more than the overcrowded native holdings. The problem of the outbreaks is still unsettled.

For any introduced insect to establish control over *Promecotheca reichei* in Fiji it must be able to withstand drought conditions and be sufficiently oligophagous to survive between the outbreaks of the beetle.

A stick-insect (*Græffea crouani*) (2) called "mimimata" by the natives causes severe damage to the leaves, which are so eaten as to leave a deeply notched margin, or even only the midrib. This Phasmid is nocturnal, being found by day resting in the folded leaflets of the coconut trees. The female, which measures 11 cm., exclusive of the antennæ and gonapophyses, carries the male which is 8 to 9 cm. long. The resting position of both sexes is

with the first pair of legs extended more or less parallel with the body. A white fluid with an unpleasant odour is ejected backwards from a pair of prothoracic tubercles when the insect is disturbed.

The egg, which measures 6 mm. in length, 2.75 mm. in width and 2 mm. in thickness, is light brown to chocolate in colour and deeply and irregularly pitted. It has an obliquely placed mammiform lid, a crater-like hilum on one side and a keel on the opposite side, the whole, as is usual in this family, simulating a seed in appearance. The incubation period is three months.

This is often locally a very serious pest. Jepson (3) writing in 1911 states that it does considerably more damage in some places than *Levuana* which was then of paramount importance. It is found also in Samoa, and was taken by Simmonds (4) in Wallis Island and Futuna, though here there may be a different species as the synonymy is still very vague, *Lopaphus cocophagus* and *Graeffea cocophaga* being also used.

It was noticed in Taveuni that the insect was most abundant where there was long grass, especially buffalo grass (*Stenotaphrum americanum* (*secundatum*)) at the foot of the trees.

Grease-banding of the trunks to prevent the ascent of apterous females and nymphs, and smoking by fires lit under the trees are suggested methods of control. The introduced Australian magpie (*Gymnorhina*) and the Indian mynah (*Acridotheres tristis*) are said to be very useful in Taveuni as controlling agencies. The removal of tall grass from the plantations is to be recommended and would expose the eggs, which are showered down from the trees, to ant attack.

Blow-flies.—*Chrysomyia* (*Calliphora*) *rufifacies* and *C. megacephala* are the two blow-flies which do most harm in Fiji. On one estate in Taveuni where these flies were serious it was found that kerosene rubbed into the affected parts after shearing around the area killed the maggots and pupæ, though it caused a sore.

Rats.—Nearly all planters seem agreed that rats, and not fruit-bats (flying foxes), are the only mamalian pests. The bats (*Pteropidæ*) were seen to be feeding on male flowers which often fell down in a shower, but no damage to female nuts was noticed. Rats, *Epimys* (*Mus*) *rattus alexandrinus* and *M. norvegicus*, on the contrary may be very serious and breed in the tree-tops—one tree may sustain quite a number. In Taveuni many three-quarters grown nuts were found on the ground with rodent tooth-marks. Taylor (5) has shown that trees near a permanent supply of water do not suffer so much, pointing to lack of moisture as the main reason for the damage.

Pigeons.—These birds spread both *Clidemia hirta* and *Lantana* seed by means of their droppings, their crops are often crammed with both kinds of seeds.

Clidemia hirta.—Around Levuka this weed was noticed early in March to be very robust and thrifty. No liberation of the West Indian *Liothrips urichi* has been made on Ovalau. In Taveuni one colony has spread nearly a quarter of a mile from the original site, the insects were well established and ovipositing and the plants were wilted. On the same estate, and only a mile or two away, another colony liberated at the same time was not recovered at all. The interval between liberation and the visit was six months—September, 1930, to March, 1931. Both sites were on fairly high ground, but where the parasite was recovered there was a continuous wind-break of trees. At Quacavula and Ura no traces of the insect were found. On several estates in Taveuni, Mauritius bean (*Stizolobium aterrimum*) and *Dolichos hosei* were being used with some success as smother-crops against this weed.

Psidium guayava (guava).—This has already become so serious in Taveuni that certain blocks of coconut land have had to be abandoned before it. On one estate alone more than 1,000 acres have been thus sacrificed. This plant is worse where the soil is friable than where it is clayey. Sodium chlorate spraying is considered fairly satisfactory if repeated after the shoots re-appear, but any pieces of roots which are left after attempts at eradication by digging are certain to grow up.

Lantana crocea and *Lantana camara*.—These verbenaceous weeds were seen to be very abundant at Ura, and generally along the south-west coast of Taveuni. Despite a temporary check from the Mexican Tingæid (*Teleonemia lantane*) introduced from Hawaii in 1928 this weed has sprung up again and was very dense and seemed to be spreading.

Stachytarpheta dichotoma (blue rat-tail).—This plant seems present everywhere throughout the Group and was growing luxuriantly at Vanua Balavu in Lau. In several instances it had passed from the herb to the shrub with a stem $1\frac{1}{2}$ inch in diameter. White flowers in place of the normal blue were occasionally seen. Here again, an attempt to introduce parasites from South America would be worth a trial, perhaps concurrently with work on *Psidium*.

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* POSSIBILITIES OF THE COLONIAL CANNING INDUSTRY.

By Sir EDGAR JONES, K.B.E., Chairman of the Empire Canning Council.

(An intentionally provocative article, urging in particular the necessity for capital development of Colonial canning to compete in World markets, a field of vast potentialities.)

ENGLISHMEN have not been successful in the industry of agriculture at home in Great Britain. They have failed to apply modern improvements, organisation, and mechanisation to the oldest of industries. The lamentable conditions that have resulted in agriculture have had personal consequences; the young men of brains and character have entirely deserted agriculture and have turned for fame and fortune to other industries. In these, there is an atmosphere of enterprise, activity and progress: there are institutes and clubs of mining, marine, electrical and wireless engineers, but where are the institutes and clubs of agricultural engineers?

In the more academic science of soils and products there are institutions and students whose research knowledge is the finest in the world. But modern organisation and engineering development in agriculture are lacking in Great Britain.

THE CANNING INDUSTRY ABROAD.

In America and Japan, and more recently, in the Dominions, the canning industry has been found to have as remarkable an effect on the mechanisation of agriculture as the motor car has had upon transport. The enormous agricultural production of certain localities in America, otherwise similar in

* From *The Crown Colonist*, April, 1931.

condition to rural England, has been created by the machinery of canning. What the mechanisation of the canning industry can do has been more dramatically exemplified by developments in Japan than those of almost any other country.

In America, before the war, the production of tinplates was about the same as the British production, but to-day the American production is double the British production. In 1913 about 700,000 tons of tinplates were consumed in the United States. To-day that consumption is around 1,400,000 tons. About 76 per cent. of the tinplates used in the United States is used for canning foodstuffs. It is estimated that the output of canned foodstuffs in America is now worth over £200,000,000 annually.

Canada, Australia, South Africa and New Zealand have made substantial progress in the canning industry, and the indications are that there will be a large expansion of canning in those Dominions in the future.

It was owing to the failure to understand the possibilities of a canning industry and to apply this modern mechanisation to agriculture in England that plant and machines for factories were not originally manufactured in this country, and the production of cans was inadequate and inefficient. In the past four years, this has been changed with an astonishing measure of success and the mechanisation methods of the canning industry have in England been applied to fruits, vegetables, soups, mixed foods, fish and other products. As a result, substantial engineering firms are now making cans efficiently, some are manufacturing plant for making cans, and others are manufacturing plant and equipment for the canning factories.

At long last, Englishmen are awakening to the practical utility of this modern industry for the revival of agriculture at home and for its development throughout the Empire. Young men seeking a career will now include this industry as one worthy of their best efforts.

Up to the present Englishmen have been lacking in leadership in this direction in the Colonies. Americans have developed a great pineapple canning industry in American Colonies, and the Chinese have developed a similar industry in certain British Colonies, but the initiation, stimulation, and organisation of a canning industry have not been taken up by Englishmen, and they have not organised native capital and enterprise in that direction.

If the four Dominions and Great Britain are excluded, it is found that the total consumption of tinplates in the canning of food-stuffs in India and the Colonies is only about 20,000 tons per annum against the America consumption of 1,400,000 tons.

The Colonies and India have, comparatively speaking, no substantial canning industry. Those countries, however, have a population of 380,000,000 consumers, and if we add the other native populations adjoining the various parts of that Empire a total of over 800,000,000 is arrived at. This vast body of consumers eat food-stuffs like the consumers in other parts of the world. Amongst them, as in other parts of the world, there are similar problems such as gluts, shortages, seasonal crops, and marketing difficulties. These consumers also require special food-stuffs different from European food-stuffs. Very little has been done as yet to utilise the economic efficiency of the canning industry for the preservation and distribution of the special foods of this vast population, as has been done for the food-stuffs of the American and European populations.

A new era is beginning, however, and Englishmen to whom the populations of the various Colonies look for leadership will, we may hope, be henceforward starting a new mechanisation of agricultural production throughout the Empire.

POSSIBILITIES IN THE COLONIES.

There are enormous possibilities, but it is very important that developments should begin with a right understanding and on sound lines. It must always be remembered that the main function of a canning industry is to provide and preserve products for the local population. There is a great need for milk products, fish products, and poultry or meat products with beans or other vegetables amongst the native populations. In this direction, in many parts of the Empire, there is unlimited scope for the future. Factories for such local purposes do not require a large amount of capital or elaborate plant. The essential machinery for a cannery which would provide for the most modern treatments need not cost more than about £400 for a small commercial unit, and the machinery for making cans for such a unit need not cost more than about £300.

In the past, when British territories have started a canning industry, they have had to go to America for the machinery for canning and for the making of cans. They can now, for the first time, come to England for technical advice and for plant and machinery. Technical information as to the treatment of products is easily available and classes of instruction are open in England for students from the Empire. Further information can be obtained from the Empire Canning Council, 12 Whitehall, S.W.1.

At first we shall be met with statements that there is nothing useful to can for local population. Such statements can now be declared to be wrong, and if the Agricultural Departments of every Colony will make practical trials, initial assumptions of this kind will soon be disproved.

CANNING FOR THE WORLD MARKET.

There are no serious marketing problems about this side of the canning industry; when it comes to the other side, namely, the mass production of special products in a Colony for sale in England, America and Europe, then the conditions are different. There must be substantial capital and organisation to break through the competition in the organised world markets. This is where the help and leadership of Englishmen must be substantial in order successfully to place on the market such canned goods as peaches, tomatoes, pineapples and mangos, and this will require powerful commercial resources. Great things could be done in this direction if large corporations were available in England to organise the marketing end of a chain of factories in the Colonies. What Cadbury has done for cocoa, Lipton for tea, Lever for palm oil and the margarine firms for nuts, can be done for canned products of the Empire on a great and successful scale.

Even for the small producers in the Colonies, however, there are at the moment opportunities in the world markets. Canned grapefruit, figs, and dates in syrup are new to the world markets, and they are yet occupied by the American producers. There is a big opportunity for the Colonies in these newer canned products. If they delay even two years, they will find that once again they have neglected a splendid opportunity.

The importance of this matter to British and Colonial trade development cannot be over-estimated. Details of what has been done in foreign countries, and of what may be done throughout the Colonies are given in a paper read before the Royal Society of Arts in April, 1930, to which readers of this article are referred for further information.

STEAM-DRIED COPRA.

INFORMATION regarding a special shipment of copra prepared at Mua Estate, Taveuni, and dried in the new steam drier there, has been courteously furnished by the Coconut Planters' Union Limited. The shipment was handled in London by Messrs. L. M. Fischel & Co. Ltd., and specially reported upon by Loders & Nucoline Limited, one of the firms of the Unilever group. The report on the copra is as follows:—

“ RMA 194 FMS PLANTATION FIJI SOUTH SEA, 171 BAGS MARK
MUA/CPU EX S.S. ‘SIERRA.’

We give below the report on this parcel of copra as requested in your letter of 5th inst.

Good white copra above usual standard, appearance equal to high grade, some pieces rather thin. Some green mould indicating excess moisture.

Bags packed very tight, giving approximately 180 lb weight compared with usual 154 lb/160 lb. There was no evidence of oil having been pressed on to bags due to tight packing.

The analysis as compared with average of reference samples of FMS Plantation Fiji is:—

			171 bags. per cent.	Ref. samples. per cent.
Oil content	..	..	66.0	68.4
Water	..	..	4.5	3.1
FFA	..	..	1.2	4.5

We class this copra in dust Group A and colour Group A.
We wish to draw attention to the low oil content.”

Messrs. Fischel & Co. Ltd. comment on the consignment in these terms:

“ You will see that the copra marked MUA/CPU 171 bags Fiji copra, is really a very good analysis; the f.f.a. is low, while the oil contents of 66 per cent. is quite good, although the Unilever draw our attention to the fact that the contents is lower than usual. We have had a small open sample of this copra in the office and must say it is really very nice quality and should command a small premium over usual Plantation, although this is not easy to obtain.”

THE IMPORTANCE OF GRASS.

(From “ Increased Butter-fat Production ” by H. W. HERN
in *The New Zealand Dairyman*, Feb. 20, 1931.)

THE grass pastures are the indispensable crop of the farm. The grass under our feet is the natural forage, the healthiest and most nutritious food for milking cows. If there was throughout the milking season an abundance of rich, succulent, short and growing grass, little else would be needed to help and maintain the increase of milk and butter-fat. The growing of supplementary forage and fodder crops to provide adequate supplementary feed for the herd has been strongly advocated by the writer; but it must be remembered that these crops are intended only to supplement, not to take the place of, our pastures. The grass of a carefully-managed pasture produces more milk than comes from any other source of food grown on the farm. The only profitable system of dairying is to maintain the pastures in the best and most productive conditions possible, and by wise management to utilise

the grass so obtained to the best possible advantage. Permanent pastures are the dominant feature of the agriculture of this country, and the character and use made of the pastures determines the stock-carrying capacity of the land. The improvement of our pastures is a matter of vital importance. Yet an inspection of the permanent pastures shows, in practice and in fact, that the majority of our grass lands are not being properly managed, are not producing the grasses and clovers that they are capable of growing, and all too frequently they contain a large percentage of inferior grasses and useless weeds.

PASTURE MANAGEMENT.

The management of our grass lands is concerned firstly, with increasing the total production of the pasture, as far as is economically possible, with plants of first-class feeding value; and, secondly, in the utilisation of this maximum grass production to the fullest extent. It is essential that feeding should be continuous, spring, summer, autumn, and winter. The winter feeding of cows plays a very important part in production. Mixed pastures are better than pure ones, where they can be successfully maintained, because they provide a mixed fodder with a varied palatability of feed, which is preferable to a pure one for cows. The various grasses and clovers also vary in their rate of growth during different periods of the year, and as the larger number of our permanent pastures are more or less continuously grazed, it follows that continuous grazing can be satisfactorily achieved only on land where the various grasses and plants constituting the permanent pasture yield their maximum growth at various periods throughout the year. Although the laying down, preservation and management of our permanent pastures is a matter of vital importance to the dairy farmer and to the Dominion, it is a regrettable fact that the majority of our pastures are not really productive, nor are their contents anything approaching plants only of the highest feeding value. The following are some of the factors of pasture mis-management urgently needing attention:—Unsuitable mixtures sown in the first instance, neglect of necessary care in seeding, the predominance of short-living grasses in the place of more permanent ones, inferior grasses and weeds, want of proper drainage, absence of lime, want of proper management with regard to stocking, allowing the grass to get away beyond the proper length of maximum feed value, want of utilisation of excess growth as silage during period of abundance, want of manuring with the soil deficient in fertility, and top-dressing with fertilisers at the wrong time or so as not to extend the period of pasture growth during periods of shortness of growth.

Grass is now looked upon as a crop, which should not be allowed to grow beyond a height of from four to five inches, when it is rapidly fed down and then spelled to grow again. This pre-supposes three main factors of pasture management—closer subdivision, regulated stocking, and suitable top-dressing. As the majority of our dairy farms are not yet sufficiently subdivided to allow of the complete control of the pasture growth during the summer period of abundance by means of grazing, all surplus growth should be mown and conserved by ensilage for use in periods of pasture shortness. What is required in our pastures is not an abundance of grass growth, but a continuous growth of young leafy grass. The feeding value of grass has now been shown to rapidly lessen as it gets older, being long past its best at the flowering stage and containing half as much protein as it did when young and a large amount of indigestible matter. Grass in the young leafy stage is as rich as clovers in protein and is almost completely digestible by the animal. The aim of the dairy farmer should be to control the pasture

growth by careful rotational grazing and management, so that the grass is kept short and succulent, and the pastures in the best and most profitable condition of herbage in continuous growth in the young leaf stage. A more general adoption of intensive grass management cannot but result in a material increase in butter-fat production.

EFFECT OF HIGH LAND VALUES.

An important factor which has contributed to retard the better improvement of our pasture lands is the fact that too many farmers, since the war period, have shifted from one farm to another. A good many land-owners were more speculators than real farmers, being more interested in the profit likely to be made on resale of the land than on the permanent improvement of their pastures and the maintenance of fertility of their land. As long as this state of affairs continued, the personal interest and enthusiasm necessary for success was lacking. The bad times, with consequent re-adjustment of land values, through which we are passing, will check this tendency. It should make our farming more permanent, with the return to be obtained from the soil, on the re-establishment of the dairying industry on paying and profitable lines, of the first importance.

THE NEED FOR SUPPLEMENTARY FEEDING.

The critical pasture periods and the need for adequate supplementary feeding to maintain the maximum milk production was dealt with fully in the article entitled "Supplementary Feeding," published in the *Dairyman* for July, 1930. Although the grass is the natural food of the cows, it is becoming more evident that our dairy farmers have in the past depended too much on the grass alone, and that the feed produced by our permanent pastures should be supplemented with hay and roots in winter, and silage or grass forages in the summer and autumn, if we are to obtain the maximum milk production of which our cows are capable. It is only by making suitable preparation that a supply of feed will be available in the days of scarcity, when a sufficiency of feed is of essential importance in successful dairying.

THE IMPORTANCE OF TOP-DRESSING.

On all our dairying grass lands the most important means of increasing the production of the pastures is by adequate and suitable top-dressing. In dairying this is a most important phase of farm management, and the annual application of fertilisers should be looked upon as important as the daily milking of the cows. The outstanding feature of the manurial requirements of the soils of New Zealand is the major importance of phosphatic fertilisers. On dairying pastures lime also is required. In addition to improving the actual yield, phosphatic manures assist the growth of first-class grasses, and by improving the quality of the herbage play a most important part in the health, constitution and vigour of the stock which graze on pastures treated with lime and phosphoric acid.

The modern tendency in top-dressing pasture lands is not to apply fertilisers to increase the grass growth during the period of normal maximum growth, but rather so as to stimulate growth in the early spring, autumn, and winter. The object of top-dressing in future will be to make the pasture growth as continuous and even as possible throughout the year. It is not in times of pasture abundance that additional growth is required, but it is in times of lessened pasture production that increased herbage is of the greatest value.

THE VALUE OF BREEDING.

Breeding is a most important means of increasing the butter-fat output of our cows. Herd-testing should be universally adopted, and at the same

time farmers should realise the necessity of having pure-bred bulls at the head of their herds. The practice of keeping any kind of bull, so that the cows were put in calf, has been far too common in this country. This was particularly noticeable in the case of too high priced dairying land, where a farmer was compelled to over-stock with milking cows, so that he could not keep any heifers, and the calves were killed. If all the calves were killed it would not have mattered very much, but unfortunately many farmers kept what they regarded as their best calves, knowing full well that they were the progeny of a scrub bull. This practice has perpetuated one of the troubles of our dairying industry: the low butter-fat production of many of our milking cows.

The important thing in working up a good herd is to have a good foundation. The breeder should first choose his breed, and having selected the type he wants, keep to it. A start can be made in a small way, with a good sire and a few cows. It is much better to have a few cows of good quality than a large number of average nondescript type. Line breeding is the most successful way to establish continuity of type. It is not necessary to sacrifice type for production, and to mate the progeny of a cow of record butter-fat production with a herd of pedigree line-bred cows more often than not leads to disappointment. Many of the best performers in the Dominion semi-official test are typical of their breed and line-bred. In the Island of Jersey, importation of foreign cattle has always been forbidden, and the Jersey cattle have been bred from a type and butter-fat standpoint. By line-breeding the pedigree of a certain strain is followed right through, with preservation of type. Although it is true that half the breed goes down the throat, it is equally true to say that the bull is half the herd. In any effort to assist the re-establishment of the dairying industry by increasing the production of butter-fat, the permanent factor of improvement is a herd of higher-producing cows.

LIME IN PASTURES.

(From *The New Zealand Dairyman*, Jan. 20, 1931.)

DR. J. B. Orr, of the Rowett Institute, dealing with the importance of minerals in the feeding of dairy cows, says:—A cow giving four gallons of milk per day secretes daily in the milk 1.0 oz. calcium, 1.3 oz. phosphorus, 0.4 oz. sodium and 0.64 oz. chlorine. These are taken from the living tissues of the animal, and unless she can absorb from the intestine sufficient to replace this loss, the tissues become depleted. In most heavy milking cows there is, during lactation, a progressive depletion of the skeleton. It has been estimated that a cow may lose as much as 20 per cent. of the mineral matter of the skeleton during a lactation period. The writer has suggested elsewhere that the depletion of the tissues of heavy milking cows may be the cause not only of decreased milk yield in subsequent lactations, but of difficulties in breeding, and an increased susceptibility to disease.

The element which presents the most difficult problem is calcium. The fodder fed, especially if it includes good hay, will contain more calcium than is secreted in the milk. Even if an abundance of calcium be provided in the food, however, there is difficulty in getting a sufficient amount absorbed from the intestine. The calcium in green food is more easily assimilated than the calcium in concentrates. It is also better assimilated from well got hay which has been little exposed to the elements after cutting than from hay which has been badly weathered.

The statements made by this authority suggest that the addition of lime to the pasture and keeping up a sufficient supply of lime at all times in the soil would increase the supply of lime in the grass and particularly in the clovers and trefoils and this would not only tend to increase the milk yield of the herd, but would be largely instrumental in preventing diseases and disorders in dairy cows and would play an important part in developing the frame of the calf. The presence of rock salt on pastures where the cows can lick it when so inclined is also valuable in maintaining the health of cows.

THE COCONUT MOTH IN FIJI.

A RECORD of the work undertaken by the Coconut Committee for the control of the Levuana Moth of coconuts in Fiji, has been published under the above title by the Imperial Bureau of Entomology. The account of this most interesting and successful campaign for the control of one of the most serious pests of coconuts in the Fiji Group has been compiled by Dr. J. D. Tothill, T. H. C. Taylor and R. W. Paine. The book (Crown quarto) comprises 265 pages of letter-press and 24 plates, the originals of many of which were prepared by H. W. Simmonds.

The record of this highly organised and relentless campaign against an enemy which bade fair to make the production of copra in Fiji unprofitable is one of absorbing interest, particularly to workers in other territories who are faced with problems concerning the biological control of serious pests.

The contents include an introduction and a historical account of previous work, followed by a general account of the campaign instituted in January, 1925. The Levuana Moth is fully described, as is also the Tachinid Fly, *Ptychomyia remota*, which was successfully introduced, bred and distributed locally. The report is supported by descriptions of allied Zygaenids and notes on their natural control, together with an account of the predacious beetle, *Callimerus arcufer*. The book is primarily one which will interest students of economic entomology and it should form a valuable acquisition to the libraries of Research Institutions which are concerned with entomology.

Copies may be obtained either from the Department of Agriculture, Fiji, or from the Imperial Bureau of Entomology, Queen's Gate, London, S.W.7, at a cost of £1 11s. 6d.

The publication was authorised by the Coconut Committee of Fiji, who bore all expenses connected therewith, and forms a valuable record of protracted investigations carried out under their direction.

SEEDS FOR DISTRIBUTION.

THE following seeds are available for distribution on application to the Department of Agriculture, Suva; or the Government Experimental Farms at Navuso, near Suva, and at Sigatoka:—

- (1) Paddy Rice, variety "Sonacalif." A quick growing, early rice, seed of which can be obtained in limited quantities at 2s. 6d. per benzine tin, containing about 28 lb.
- (2) Mahogany tree seeds from the West Indies:—
 - (a) *Swietenia mahogani* (West Indies mahogany).
 - (b) *Swietenia macrophylla* (British Honduras mahogany).

These can be obtained free of charge.

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE
DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 4.]

THIRD QUARTER, 1931.

[No. 3.

INTRODUCTION.

THE records of experimental work on the improvement of methods of preparation of copra are scattered through a wide range of publications. The present account deals with investigations primarily directed to the study of possible simple methods for adoption by small producers in the Colony of Fiji, having for their object the prevention of rapid deterioration of copra by mould attack.

The Coconut Committee allocated funds for the construction of the sulphuring chamber which was designed by Mr. H. R. Surridge, who carried through the experimental part of the work. Mr. W. J. Blackie conducted the chemical examinations of the material in Fiji, and together these officers have presented an interesting paper which should prove of value not only to Fiji but to workers in other places who are confronted with similar problems.

The Imperial Institute, to whom samples of the copra prepared by Mr. Surridge were referred for further examination, have furnished a comprehensive and valuable report, a summary of which is published. The co-operation and assistance accorded by the Director of the Imperial Institute and his staff are gratefully acknowledged.

A. C. BARNES,
Director of Agriculture.

THE IMPROVEMENT OF FIJI COPRA.

SECTION I—A.

By H. R. SURRIDGE, A.R.C.Sc. (I.), Agronomist, Coconut Committee.

OWING to the high proportion of very low-grade copra produced in and exported from these islands, Fiji copra has been classified as "low grade" on European and other markets. This low-grade copra is mainly produced by the native who employs primitive methods and lacks organisation and the economic urge to produce a first-grade product. His plantations consist invariably of isolated blocks of coconuts, of varying sizes, in all manner of locations, the larger plantations being on the coast line, the smaller blocks scattered along river banks and hill sides. Until recently these plantations had received no cultivation, but under the instruction and direction of the Inspectors of the Coconut Committee this matter has been and is receiving attention. The collection of nuts is spasmodic, depending, if anything, more on the desire for luxuries rather than the want of necessities. When the nuts are collected they are usually old and many have germinated, so that under the best conditions a poor quality copra would be produced, but to the low-grade of nuts used must be added the methods adopted in curing the meat. The native treats his green copra in one of three ways:—

- (1) without husking, he splits the nut and lays it open on the ground without any protection from the weather, &c., for the preliminary drying, prior to extraction of the green meat from the shell;
- (2) as in (1), except that instead of laying the nut on the ground the halved nut is hung up by the fibre on lines between coconut trees. Under favourable weather conditions a comparatively good quality copra results, but during rainy weather such copra is usually left unprotected with the result that it rapidly moulds and deteriorates;
- (3) after splitting the nut the green meat is cut out and placed on reed vatas (shelves) to dry in the sun. Given good dry weather some very good copra is produced, but during rainy weather the copra is either left uncovered or gathered into a heap and any covering material handy, *e.g.*, sacks, corrugated iron, &c., is thrown over it and the whole left indefinitely. Under such conditions moulds and insects soon attack the copra and reduce it to the lowest grade.

The marketing of this product raises other questions and problems, three points of which are here briefly discussed:—

- (1) it is customary for some natives to cut green copra, bag it and sell to a dealer. Subsequent curing does not always obviate the result of sweating due to the bagging of the undried material, because many dealers have not the facilities for quick and efficient drying;
- (2) the native with "get rich quick" ideas will mix green copra with cured copra with dire results to both. His idea is to make up his weight irrespective of the quality of his produce;
- (3) adulteration with foreign matter.

Nos. (1) and (2) still obtain throughout many parts of these islands, but No. (3) is not favoured by the native as much as hitherto. These are some of the factors which have caused Fiji copra to be placed on such a low grade, so much so, that the progressive planter who is producing a first-grade

article finds great difficulty in securing adequate recognition of his superior grade copra owing to the generally poor quality of Fiji copra.

Sulphuring.—In the effort to improve the quality of Fiji copra in general and the native copra in particular, the question of the treatment of the green meat by sulphur fumes (SO_2) has been considered. Some progressive planters sulphur their copra with beneficial results. In other countries sulphuring (2) has been used with good results for some years, and it was considered therefore that provided a suitable equipment could be designed to meet local conditions, the same method might, with advantage, be applied to native copra here in Fiji. For this purpose a portable sulphuring chamber, having a capacity of 1,000–1,500 nuts, the equivalent of about a quarter of a ton of dry copra, was designed. Its construction was such that it could be dismantled and assembled quickly, was fool-proof, could be made locally, and could be transported by hand labour from place to place.

It might here be mentioned that the native is in most districts familiar with the use of a sulphuring chamber for medical purposes, and it was considered that with such knowledge it should be an easy matter for him to operate the copra sulphuring chamber.

Having designed such a chamber, it was essential that it should be thoroughly tested, and, in so doing, to obtain all possible and practical knowledge of the resulting product. For this purpose a series of copra sulphuring experiments were designed to demonstrate the effectiveness or otherwise of the chamber for the purpose for which it was to be used in the field, and also the quality of the sulphured copra under varying conditions of treatment. The following paper gives details of the sulphur chamber and the experiments carried out with it.

THE SULPHURING CHAMBER.

The plans and specifications appended, give a good idea of the type of structure used, its portability and its capacity. The chamber consists of a large wooden oblong box of the following dimensions:—

Chamber (internal measurements) .	6' 6" by 4' 6" by 3' 4"
Sides	6' 6" by 4' 6" each.
Ends	4' 6" by 3' 10" each.
Roof	6' 8" by 3' 10"
Trays	6' 3" by 3' 3" by 6" each.
Brace	3' 4" by 2" by 2"

Sides.—6" by 1" boards are used for the sides, held at the ends by 3" by 2" timbers and strengthened towards the centre by two 3" by 1" battens, 15" apart; 2" by 2" timber runs the length of the top between the end 3" by 2" timbers. This carries the three bolt holes for attaching the roof as well as strengthening the length of each side. At 1' from the bottom, on the inside, a 3" by 1" batten running the whole length of each side, is fixed. These battens constitute the only set of runners carrying the trays of copra. At one end, about 3" below these runners, a slotted wooden bracket is fixed to take the tongued end of the brace. This brace prevents the sides from spreading during loading and unloading operations, and is easily removable when it is required to place the sulphur burner in position at the bottom of the chamber. It should, however, be replaced after insertion of the burner and prior to the sealing of the chamber. Bolt holes must be drilled through the 3" by 2" timbers at each end and the 2" by 2" timber at the top, as indicated on the plan.

Ends.—The ends consist also of 6" by 1" boards held together on the short ends by 3" by 1" battens. Bolt holes are drilled to correspond in posi-

tion and size with the three holes drilled in the 3" by 2" timbers of the sides, as shown on the plan.

Roof.—The timber used for the roof consists of 6" by 1" boards, 3" by 2" timbers and 2" by 1" battens. The structure overlaps the walls to secure an efficient gas-proof box as well as for convenience of handling. Two 3" by 2" timbers are used to hold the ends of the 6" by 1" boards, and one at the centre for strength. Between these timbers and at the sides, 2" by 1" battens are fixed to assist in the alignment of the sides, to improve the gas holding qualities of the chamber and to strengthen. Three bolt holes are required on each side in the positions indicated on the plan and corresponding with the holes drilled in the side walls.

Note.—It is advisable to drill all holes about 1/16th of an inch larger than the size of the bolts to be used. This will facilitate their insertion and removal.

Trays.—The construction is simple and strong with a capacity of 150–200 nuts, without overloading. The trays are made of 2" by 1" battens with 3" by 1" diagonals, slotted at the centre and where they meet the cross struts, thus giving a very rigid frame. The bottoms are covered inside with $\frac{1}{2}$ " mesh wire netting. The sides and ends consist of a double length of batten separated by an air space of 1", giving a depth of 5" inside and 6" outside. These details apply to six out of the seven trays for this chamber. The seventh tray differs only in depth, being 1" shallower than the others. This is because the cross timbers of the roof do not allow clearance for the seven trays of a depth of 6". The wire bottom and the grid sides of these trays allow for free circulation of the gas throughout the chamber. On each of the sides and at the centre of the sides, wooden runners with bevelled edges are fixed to enable one tray to slide easily over the tray underneath. It is advisable to cut the four pieces of wood supporting the sides of the trays $\frac{1}{4}$ " short since, owing to differences in shrinkage, particularly of new wood, these short pieces are apt to protrude slightly above the long battens forming the sides and interfere with the free running of one tray upon another. Screws should be used in preference to nails wherever possible, particularly in the construction of the trays. On completion of the chamber and trays a coating of creosote is recommended. Bolts with "butterfly" nuts are required. Such nuts facilitate assembling and dismantling, and are not easily lost. It will be noted that the length and breadth of the trays are $\frac{1}{2}$ " short of the internal dimensions of the chamber thus allowing for a certain amount of play and increasing the facility in loading, gas circulation and sealing, an important factor in wet weather.

Method of assembling.—Place the two sides opposite and parallel to each other, sufficiently apart to fix the brace in position. Next take one of the ends of the chamber and bolt it to the sides at the end farthest from the brace. Now place the roof in position and bolt securely. The chamber is now ready for loading.

Loading.—Having filled a tray with freshly-cut copra place it on the runners and push it right home so that it fits just inside the chamber. Repeat with each tray, running the filled tray over the tray underneath, until the chamber is full.

Sulphur charging and sealing.—Remove the brace and place the sulphur burner with its charge freshly lit, as far under the bottom tray as the arm can reach. Replace the brace, bolt the door or end securely, and the chamber is now sealed for sulphuring the green copra. It will be found advantageous to earth up lightly around the bottom of the chamber to

ensure a more perfect retention of the gas during the time the chamber is sealed, particularly if the floor is uneven.

Sulphur burner.—For the purpose of this sulphur chamber, a strong portable burner made out of materials usually obtainable from any store-keeper in these islands was used. It consisted of an enamelled fry-pan to which was fixed four stout wire legs to support, overhead, a large enamelled plate. The object of using enamelled-ware was to avoid the action of the fumes on iron-ware and so ensure long life to the burner. The height of the burner and cover was 9", allowing a clearance of 3" between the top of the burner (enamelled plate) and the bottom of the lowest tray. The plate is considerably larger than the fry-pan, the dimensions being: diameter of plate, 14"; of fry-pan, 9". These dimensions secure efficient covering for the sulphur flames and thus eliminates risk of fire. The utensils used are not essential since benzine or kerosene tins could be adapted for the purpose, but such a burner as described is very strong, durable, easily handled, safe, and in the long run inexpensive.

Effective sulphur burning.—Many users of "flowers" of sulphur for fumigation purposes have experienced difficulty in securing complete combustion of the sulphur. During the course of these experiments similar difficulties were encountered, but were eventually overcome. It was found that as the charge of sulphur increased so an increasing proportion of unburnt sulphur remained in the pan. This as far as could be judged, was not due to lack of air. The first attempt to secure complete combustion was made with dried wood chips soaked in a 1 per cent. solution of potassium nitrate (KNO_3) and mixed with the "flowers" of sulphur. A slight improvement was noted. A similar trial, using potassium chlorate was made, with the same result. The suggestion was then made that a catalyst was probably required to assist the sulphur to burn. A small cast-iron grid was obtained and the sulphur placed on and around it. This was not successful.

Finally, the dried husk of a coconut was taken and some of the fibre teased out and laid on the fry-pan in a rough circle. A layer of the sulphur was placed on this, then alternate layers of fibre and sulphur, until the required amount of sulphur had been utilised. Two layers of each were found sufficient for eight ounces of sulphur. A match was then applied and it was noted that the fibre and sulphur burnt intermittently, slowly but surely, until all the sulphur was consumed, leaving just the charred framework of the fibre. In all burnings carried out in the manner just described, the result was always complete combustion of the sulphur. This represents a simple and effective method of burning sulphur on the plantation, since coconut husks are always obtainable, one husk being sufficient for several burnings. Experiment would indicate the amount required for the particular charge of sulphur being used. This method has since been tried out and adopted on a commercial scale with marked success, no difficulty being experienced in the burning of charges up to 5 lb of sulphur at a time, this amount being the maximum attempted.

COPRA SULPHURING EXPERIMENTS.

To secure results which should be of the greatest service for the conditions obtaining in Fiji, the coconuts used in these experiments represented a fair sample of nuts such as would be used by the native for the production of his copra. The nuts were obtained from native plantations in the Lower Rewa district near Suva. About 8,000 of them were required to make one ton of copra, and they were gathered within a month of the hurricane which visited these islands in December, 1929. Native collection of nuts is, as already stated, spasmodic, hence the heavy proportion of old nuts that were

present amongst those supplied for the making of copra in this experiment. It should be mentioned that in Fiji it is the custom to allow the nuts to fall naturally before making them into copra, while the practice in Ceylon, Malaya and other countries (10) is to cut down the nuts from the trees when ripe.

If experiments 1, 2 and 7, trays of copra made from germinated nuts were set aside for separate observation and chemical analysis, the object being to demonstrate the difference, if any, in the quality of copra made from ripe nuts as against that made by old or germinated nuts. The nuts for experiments 1 and 2 were husked and halved before sulphuring, 1,200 nuts being easily accommodated in the sulphur chamber when cut this way. For the remainder of the experiments the green copra was cut out plantation style, in smaller pieces, fingers, &c. By this method 1,500 nuts were easily accommodated for one sulphur burning. For the subsequent curing of the meat, after sulphuring, old banana packing tables were used on which, green copra was spread. These tables consist of heavy timber tops which did not allow of a free air circulation as in the case of the usual reeded vatas (shelves) commonly in use in these islands.

Further, the season of the year 1930 (January to March) during which these experiments were carried out was the wet or rainy season when drying conditions were not favourable to good copra curing. For this particular period there were 25 days of rain during January, 19 days in February, and 23 days in March, together with a humidity varying between 68 and 100 per cent. Under such circumstances the average time taken for curing was 14 days, the minimum being 9 days and the maximum 19 days. Under dry season conditions the time required in most parts of these islands for copra curing varies from 2½-5 days. It will be seen therefore that for the purpose of these experiments the weather conditions were such as to demonstrate effectively the utility or otherwise of the sulphuring of green copra for the improvement of the subsequent product by mould control, since the longer the time taken and the greater the humidity during the time of curing, represent factors favourable to mould and other growths which bring about serious deterioration in the quality of copra.

In designing these experiments it was the original intention to use varying quantities of sulphur for the same periods of time to discover the necessary charge of sulphur required and the length of time needed to seal the chamber to secure the efficient sulphuring of the green copra. The amounts of sulphur to be used were 4 oz., 8 oz. and 12 oz., sealing the chamber for periods of 3, 6, 9 and 12 hours for each charge of sulphur. In practice it was found that certain of the time periods could be dispensed with, primarily because the sulphur charge was not strong enough to last the time required.

The experiments conducted during this investigation resolve themselves into four series, the first three dealing with the sulphuring of green copra without previous treatment and the fourth dealing with the sulphuring of green copra after a preliminary treatment. While the former confirms previous knowledge as regards the value of sulphur fumes (SO_2) (2) as a preventative of mould growths on copra under reasonable conditions of storage and transport, the latter appears to open up possibilities of treatment for the further improvement of copra rendering it less liable to deterioration by either fungi or insects during drying and storage, and requires to be tried out on a commercial scale to demonstrate its utility. This is discussed later on in this paper. Notes on the condition of the copra at the time of bagging will be found tabulated at the end of each series of experiments.

Series 1.—Four ounces of “flowers” of sulphur were used for the charge in the two experiments comprising this series.

Experiment 1.—Twelve hundred coconuts were taken, husked and split in half, the halves still in the shell—a system in use in the Philippine Islands—were then loaded on to the trays and the whole run into the sulphur chamber. Four ounces of “flowers” of sulphur were put into the burner, carefully lit and, after removing the brace, placed as far as the arm could reach on the floor under the bottom tray. The brace was then replaced, the door bolted into position, and a thin heap of sand placed around the bottom of the chamber to prevent escape of the gas. This work was completed by 4.15 p.m. and six hours later (10.15 p.m.) the door was unbolted and removed and the trays left in the chamber overnight. As a result of this a certain amount of sweating took place. On the opening of the chamber a trace of sulphur fumes was noted, and the wet meat quickly gave an acid reaction to litmus paper. With reference to this latter note, green copra usually gives a slight acid reaction to litmus, so that the rapidity and definiteness of the reaction after sulphuring suggested that some of the sulphur dioxide had been absorbed by the moist copra. On the following day the copra was spread out on tables for sun-drying, as follows:—

- (a) one tray was set aside for drying without protection from the weather and was left uncovered at night until drying was completed;
- (b) one tray of this copra consisted of material cut out from germinated nuts. This was set aside for special observation and chemical analysis, otherwise treated as (c);
- (c) the remainder was spread out on the tables for sun-drying and placed under cover at night and during rain until cured;
- (d) as control copra for this and all other experiments described in this paper, 100 nuts were cut out according to the method adopted for the various experiments, and spread out on a table to sun-dry in the usual way, this copra *not* being sulphured but otherwise receiving the same protection as (c) above.

Note.—It often occurs amongst the natives that green copra is cut out and left either on the ground or on vatas without any protection from the weather. It was required to know therefore, what influence such treatment would have on the sulphured article, hence the reason for subjecting one tray of copra in the various experiments to similar conditions.

All copra was carefully raked over each morning after exposure to the sun for about one hour. The copra of this experiment (No. 1) took 12 days to cure, intermittent showers and high humidity delaying drying. Moulds (*Penicillium* and *Aspergillus* varieties) appeared on the third day of drying and continued to increase until the ninth day, the growths appearing more persistent and more freely on the sulphured sample as against the unsulphured or control sample. This copra was finally sampled and bagged on the twelfth day of drying.

Experiment 2.—This experiment as regards the sulphuring varied only from No. 1 in that the chamber was sealed for three hours. On opening there was a fairly strong smell of gas. The weather during the period of drying was similar to that of Experiment 1. After four days of sun-drying the moulds *Penicillium* and *Aspergillus* appeared and made rapid progress, due to the humid conditions prevailing. Drying was completed in 10 days, when the copra was duly sampled and bagged.

CONDITION OF THE COPRA ON BAGGING—SERIES 1.

Expt. No.	Sulphured.		Covered. (c)	Control (not sulphured) (d)
	Uncovered (a)	Germinated. (b)		
1	Appearance fair, some moulds and brown discoloration. Quality poor.	Appearance & colour fair. Some moulds & browning of the copra. Very thin and chippy. Quality fair.	Appearance fair, rather better than control (d) although it had moulded freely. Quality fair.	Appearance fair, moulded freely. Quality fair.
2	Appearance bad, moulds very prevalent. This sample was everely attacked by the copra beetle, (<i>Necrotia rufipes</i>) and ants. Quality poor.	Appearance poor, moulds very prevalent. Quality poor.	Appearance fair, moulds present & brown discoloration. Not so good as control (d) in appearance. Quality fair.	Appearance fair, moulds present. This appears to be the best copra of this series. Quality fair.

In view of the results obtained with the sulphur charge used in these two experiments, particularly as regards the comparatively weak concentration of the sulphur dioxide gas on opening the chamber after three hours sealing and the mere trace found after six hours sealing, it was considered valueless to proceed with this quantity of sulphur to seal for nine hours and twelve hours, the quantity of gas produced not being sufficient to achieve the desired object, and the longer time within the chamber tending to induce undue sweating of the green copra without beneficial results.

Series 2.—Eight ounces of “flowers” of sulphur was used in the charge for these three experiments comprising this series. In this and the succeeding series of experiments the coconuts were treated as on the usual Fijian plantation by being split with an axe and the green meat cut out in fingers and smaller pieces instead of being left in the shell for the first day or two as in the case of Series 1. By this method the green meat of 1,500 nuts was required to fill the seven trays of the chamber without overloading. Further, it was in this series of experiments that the problem of ensuring the complete combustion of the sulphur was encountered and solved in the manner already described.

Experiment 3.—In this experiment the chamber was sealed for three hours after the burning sulphur had been placed inside. At the opening of the chamber a very strong smell of sulphur dioxide was observed. The copra was taken out and spread on the tables for drying as follows:—Sulphured—(b), uncovered; (c), covered; (d), control (unsulphured).

Note.—No copra from germinated nuts was isolated in this series. This copra took 12 days to dry. Moulds appeared on the third day, but the two following days were fine and dry and it was noted that the moulds did not visibly spread, due undoubtedly to the drier atmosphere with the quicker drying.

From the sixth day until the twelfth, when the copra was ready for bagging, the humidity of the atmosphere increased and delayed drying, with

the result that the moulds increased somewhat. On the twelfth day the copra was sampled and bagged.

Experiment 4.—In this case the chamber was sealed for six hours, and on opening a fairly strong smell of gas (SO_2) was noted. The copra was drawn out and placed on tables for drying in the order noted for Experiment 3. During the time of drying the weather was usually bright, but humidity high, this accounting for the slow drying. Moulds appeared by the fourth day but did not increase. Some browning of the copra as it approached complete curing was noted, particularly amongst that copra obtained from germinated nuts. Curing was completed on the eleventh day, when the copra was sampled and bagged.

Experiment 5.—The nuts used in this experiment had been on hand for 28 days, were ripe when originally delivered, and in the interval many had germinated. The copra produced from this sample can therefore be classed as typical native copra. In this case the chamber was sealed for nine hours, but on opening at the end of that period only a trace of the gas was observed. On due consideration it was decided therefore that to seal the chamber for 12 hours with only a charge of $\frac{1}{2}$ lb of sulphur would be of no practical advantage. This experiment therefore concludes Series 2. The copra was duly spread out to dry, but the weather was unfavourable for the first three days. Moulds appeared on the control sample on the third day, and on the sulphured copra on the fifth day, but in both cases development was slow, so that when the product was bagged on the fifteenth day of drying, moulding of the copra was not particularly marked.

SERIES 2.

Expt. No.	Sulphured copra.		Control (unsulphured) (d)
	(b)	(c)	
3	Appearance, dirty looking sample. Copra beetle (<i>Necrobia rufipes</i>) present	Appearance good, some moulds and browning due to the presence of germinated nuts.	Appearance good, some moulds and browning, as in (c).
	Quality poor.	Quality good.	Quality good.
4	As expt. 3.	As expt. 3, but appearance and quality rather better.	As expt. 3.
	Quality poor.	Quality good.	Quality good.
5	Appearance black, charred but flesh appears sound and good. Not attacked by the copra beetle.	Appearance good, very free from moulds but some browning.	Appearance fair, but moulded freely.
	Quality poor.	Quality good.	Quality fair.

The result of the experiments in this series indicates that some value may be attached to the sulphuring of the green copra, since, in the last experiment particularly, the quality of the sulphured copra was slightly better than the control.

Series 3.—Twelve ounces of "flowers" of sulphur was used in each of the experiments of this series, the burning being accomplished by using dry coconut husk, as already described.

Experiment 6.—The chamber was loaded with green copra and after the sulphur charge has been lit and placed in position, sealed for three hours. On opening the chamber it was found to be overpoweringly full of sulphur fumes and was unapproachable for some 15 minutes. After the gas had cleared, the copra was taken out and spread on the tables for drying, as follows:—Sulphured—(b), uncovered; (c), covered; and (d), control (unsulphured). During the process of drying some moulds showed on the control on the fourth day, but in the case of the sulphured no moulds were apparent until the copra was ready for sampling and bagging 17 days after the sulphuring. Although unfavourable drying weather occurred during the curing of this sample of copra, the sulphured (c) copra remained very white and dried an excellent sample in appearance.

Experiment 7.—This experiment differs from Experiment 6 in that a tray of germinated nuts was set aside for special observation, as in Series 1. This was done in view of the apparent improvement of the sulphured copra in this series. The chamber was sealed for six hours, and on opening a very strong smell of gas was noted. Fifteen days were occupied in curing this copra, moulds appearing on the control on the fourth day, but not on the sulphured copra.

Experiment 8.—In this experiment the chamber was sealed for nine hours and on opening there was a strong smell of sulphur fumes (SO_2). All the trays were taken out and stood one upon another, criss-cross, outside the chamber and under cover during the week-end. This allowed for free circulation of air between the trays whilst standing from the Saturday night until Monday morning. On the fifth day of drying, moulds appeared in quantity on both the control and sulphured (c) copra; in the latter case two trays were particularly affected. The copra of these two trays was from old nuts and germinated nuts, and it was not clear whether this excessive moulding was due to (1) the age of the nuts, (2) undue length of time enclosed in the sulphur fumes, or (3) lack of air circulation through the method of stacking the trays after removal from the sulphur chamber. This experiment was therefore duplicated, the description of which will be found under Experiment 8A. By the 10th day of drying (Experiment 8) all moulds appeared to have ceased growth. Sampling and bagging was carried out on the thirteenth day.

Experiment 8A.—This experiment duplicated Experiment 8, for the reasons already given. The chamber was sealed for nine hours, a strong smell of gas being noted on opening the chamber. The copra was spread out in the usual way, receiving protection at night and from rain during the day. Sixteen days were occupied in drying. The control sample moulded freely from the fourth day onwards, black and brown moulds predominating. The sulphured sample remained practically free from moulds until sampled and bagged. The inference drawn from this duplicate experiment as regards Experiment 8 was that the difficulty met with was not due to excessive sulphuring.

Experiment 11.—In the previous experiments of this series there was practically no visible difference in the quality of copra produced by the various periods of sulphuring, viz., three hours, six hours, and nine hours. One other experiment was devised therefore to discover whether a shorter period than six hours would be as effective and thus economise time. For this purpose the chamber was filled with green copra and sealed for $4\frac{1}{2}$ hours. On opening there was a very strong smell of gas. The copra was unloaded on to tables for drying in the usual way. Owing to weather conditions sampling and bagging was not possible until the 17th day.

SERIES 3.

Expt. No.	Sulphured copra.			Control (unsulphured) (d)
	(a)	(c)	(c)	
6	Appearance, black and charred but flesh on breaking of a good colour.		Appearance good, bright copra. Practically free from moulds except for those appearing on the "germinated"	Appearance good, some moulds.
	Quality bad.		Quality 1st grade.	Quality very good.
7	As 6 above.	Appearance good except for brown discoloration and some mould.	As (6) above.	As (6) above.
	Quality bad.	Quality good.	Quality 1st grade.	Quality very good.
8	Appearance very bad, red black, & brown moulds prevalent.		Appearance good, some moulds which appeared to die out on the copra drying.	Appearance fair, moulded freely.
	Quality very bad.		Quality 1st grade.	Quality good.
8A			Appearance very good, colour pearly white. Quality 1st grade.	Appearance fair, moulded freely. Quality fair.
11			Appearance very good, clean and white, practically free from moulds. Quality 1st grade.	As 8A, above.

This series, judging by appearance only, definitely favours the practice of sulphuring.

Series 4.—This series consists of experiments in which the green copra was first washed in a suitable medium before being subjected to sulphur fumes and then sun-dried.

Throughout the preceeding experiments it was repeatedly noted that copra during the drying process often browns on or near to the edges of the meat, this discoloration not being due to moulds. This is a common complaint amongst planters, whether the copra is sun-dried or kiln dried, and the suggestion has been put forward that this is due to the small amount of sugar deposited by the "milk" as it dries from the meat, the heat of the sun or kiln causing the sugar to caramelize and produce the brown discoloration complained of. As a preventive the idea of washing the green copra after cutting out was carried out in Experiments 9 and 12, of spraying with a chemical solution in Experiments 10 and 13, while that of sulphuring after washing was carried out in Experiments 14, 14A, 15 and 15A described in this series. A further point for consideration was suggested by the Government Chemist, viz., as to whether an economical solution of some sulphur compound could be used for the washing process which, while cleansing the meat from the "milk" and therefore the sugar, would on drying decompose and automatically form a fungicidal film over the copra.

This series of experiments was carried out, using in each case the green meat from 100 coconuts, so that the results obtained may be considered as

indicating possible methods of usefulness where success has been achieved to be developed on a larger scale to demonstrate the commercial value and possibilities. It is worthy of note that the idea of washing and sulphuring has since been developed on a commercial scale with success. This will be discussed further on in this paper.

Experiment 9.—It is generally recognised that copra dried on the beach and subject to the direct sea breeze and spray is invariably of good quality. Also, copra which has been immersed in sea water when spread out to dry in the sun is usually of good colour, appearance and quality. To demonstrate, therefore, as to whether such treatment could be recommended for general use, 100 coconuts were cut out and the green copra washed in sea water and then spread out to dry in the sun. Green moulds appeared from the third day onwards, giving the copra a spotted appearance. While these spots did not increase in size beyond that of a pin's head, the general effect was to give the copra a very poor and dirty appearance. This was due mainly to the fact that these experiments were carried out during the wet season; when atmospheric humidity is high and drying conditions generally unfavourable, as evidenced by the long time required to cure the copra. This copra was sampled and bagged on the seventeenth day of drying.

Experiment 12.—This differs from Experiment 9 in that the copra was washed a second time in fresh sea water. It required 14 days to dry this copra, when it was sampled and bagged. It is to be noted that the copra of these two experiments was not sulphured.

Experiment 10.—In this experiment the green copra was sprayed with a saturated solution of Potassium metabisulphate ($K_2S_2O_5$) by means of a "fly-tox" sprayer, 60 cc. of the solution being used. This quantity applied in this manner was found to be sufficient to ensure perfect wetting of the surface of the green copra. This copra required 19 days to dry sufficiently for sampling and bagging. It moulded freely and represented a very bad sample.

Experiment 13.—Twice the amount of Potassium metabisulphite solution of the same strength as in Experimental 10 was used in this case with a similar result. The solution was applied as in 10 above. It is to be recorded however that on the day of this experiment and after the copra had been sprayed, a whirlwind passed close to the open shed being used for these experiments so that the possibility of increased mould spore infection would occur. This copra was sampled and bagged on the twelfth day of drying in the condition recorded below. The result of these two experiments demonstrated that the particular salt used did not, on decomposition, automatically "sulphur" the copra.

Experiment 14.—In this and the three succeeding experiments some of the washed copra was sulphured while still wet with the washing solution, the charge of 12 ounces of sulphur being used, and the chamber sealed for six hours. In each case, after washing the uncured meat, the colouring matter of the brown testa of the kernel spread across the white endosperm, discolouring it, the discoloration persisting in the dried copra giving it a rather dark appearance. With the copra that was sulphured after washing, the fumes (SO_2) exercised a bleaching effect, destroying the discoloration referred to and producing a meat that was whiter than usual, and which retained this whiteness after drying. Further, it was noticeable that with each of these sulphured samples no moulds were visible and no injurious insects of any description were found although the copra beetle (*Necrobia rufipes*) was present in the other samples. Emphasis to this latter peculiarity is given in the section of this paper devoted to the behaviour of the experi-

mental copra in store. The copra of this experiment was washed in a 10 per cent. solution of washing soda (Na_2CO_3), a quarter kept for control, the remainder being sulphured for six hours, using a charge of 12 ounces of sulphur.

Experiment 14A.—This experiment differed only from Experiment 14 in that a 5 per cent. solution of washing soda was used.

Experiment 15.—In this experiment a 5 per cent solution of caustic soda (NaOH) was used, otherwise the same procedure was adopted as in Experiment 14.

Experiment 15A.—This experiment varied from Experiment 15 in that a $2\frac{1}{2}$ per cent. solution of caustic soda was used. The copra produced in these four experiments was ready for sampling and bagging after nine days drying.

SERIES 4.

Expt. No.	Washed.		Control (not washed).
	Sulphured.	Not sulphured.	
9		Seawater Covered—colour poor, moulded freely, green moulds prevalent. Uncovered, colour black, due to mould (<i>Aspergillus niger</i>). Quality of both lots, very poor.	As 8A. Quality fair.
12		As expt. 9 in both cases.	As 8A.
10		Pot. metabisulphite ($\text{K}_2\text{S}_2\text{O}_8$) Colour very bad, moulded freely blacks and greens Quality bad.	As 8A.
13		Colour very bad, worse than expt. 10, all moulds and beetles. Quality very bad.	Appearance fair, some moulds and browning. Quality good.
14	Appearance very white, sound clean copra. No moulds, discoloration or insects of any kind. Quality extra 1st grade.	Appearance fair, some greenish discoloration from the epidermis. Slight moulding, some copra beetles. Quality 1st grade.	As 13. Quality good.
14A	Appearance not so bright as 14 above. Quality extra 1st grade.	As 14 above.	As 14 above.
15	As 14 above except for slight browning on many pieces. Quality extra 1st grade.	Appearance dark due to staining from epidermis. Slight moulding, some copra beetles. Did not dry to the usual crispness as in the other samples. Quality 1st grade.	As 14 above.
15A	Appearance not quite so good as 15 above. Quality extra 1st grade.	As 15 above.	As 14 above.

From the results obtained in the washing experiments of this series it is of interest to note here that the idea of washing the copra before drying has been put into operation by E. Duncan, Esquire, at his Mua Estate, Taveuni. The copra is brought to the kiln for drying, being first weighed and then tipped on to a wire-bottomed tray under which is a draining pan. Fresh water at about 80° F., and under a natural pressure of 35 lb per square inch, is sprayed on to the green meat by means of a hose fitted with a coarse nozzle. All muck and the residue of "milk" is washed from the copra. After washing, which under this method occupies only two or three minutes, the copra is shot down on to the trays underneath and run into the kiln where in the first four hours of heating it is subjected to sulphuring. When dry this sulphured copra is exceptionally white and clean and commands a premium at the hands of the copra buyer.

CONCLUSION.

Series 1-3.—Copra sold in the various markets of the world is bought more on its appearance than on its oil content. From the buyers' point of view a copra of good bright and clean appearance will give a better quality oil than a copra that is dirty, mouldy and infested with insects; the better the quality of the oil the greater the value of that oil. In judging the copra produced in the various experiments detailed, appearance has formed the basis of quality, in other words the copra has been judged from the standard of the copra buyer.

In the section devoted to the analysis of the copra by the Government Chemist will be found a standard of quality based on those analyses, but which generally follow or confirm the standard based on appearance.

As already stated, the purpose of the experiments was (1) to test out the portable sulphuring chamber, (2) to find the minimum quantity of sulphur required to secure effective sulphuring in this chamber, and (3) to study the sulphured copra.

(1) *The Chamber.*—From the results obtained in the four series of experiments undertaken it can be said that the sulphur chamber was effective for the purpose for which it was designed. It was assembled and dismantled within 30 minutes by unskilled labour, it could be readily transported by hand labour, was easily manipulated and was gas-tight.

The Sulphur.—The minimum sulphur charge for effective sulphuring was not discovered until after Experiment 5 of Series 2. This experiment gave the first indication that sulphured copra was by appearance, rather better than ordinary sun-dried copra as shown by the control sample.

The experiments of Series 3, demonstrated that the condition of effective sulphuring had been reached both as regards quantity of sulphur required and the time necessary for the sealing of the chamber. The minimum charge was found to be 12 ounces of sulphur and the time necessary for the operation three hours. There appeared to be no difference in quality of the copra that was sulphured for three hours as compared with that sulphured for nine hours (Series 3). The suggestion here is that the strong initial concentration of gas produced by the method of burning was sufficient to sulphur effectively the copra within the first three hours of sealing the chamber.

The sulphur burns very readily during the first hour, quickly filling the chamber with fumes. After the first hour the rate of burning decreases until the mass just smoulders but the gas then produced appears to be sufficient to maintain the concentration for another hour or so, after which the gas gradually escapes, hence the conclusion drawn from the experience

of Series 3 is that effective sulphuring can be accomplished in the chamber under test by 12 ounces of sulphur in three hours of sealing.

(3) *The copra*.—For the purpose of observation the copra produced by the preceding experiments was divided under the heads:—

(d) control (not sulphured) and sulphured, the latter being subdivided into (a) uncovered, (c) covered, and (b) germinated, these subdivisions representing, in the two former, differences of treatment during drying, and in the latter a particular type of copra.

(d) *Control Copra*.—One outstanding feature of this copra was the regularity with which moulds appeared on the third and fourth days of drying on each sample of control copra. Taking into consideration the length of time required at the particular season of the year to effectively cure this copra, the quality at the time of bagging may be considered as “fair merchantable sun-dried” and represented a better sample than is the case with copra produced by the average native. This improvement of quality was due entirely to the attention given it during the long drying period, viz., of protection at night and from rain, and demonstrates how with little effort, “fair merchantable sundried” copra may be produced in place of the poor quality that results from lack of attention and interest during the drying period. Nevertheless this copra was inferior in appearance and quality to the sulphured copra obtained in the experiments of Series 3.

(c) *Covered*.—An indication of the value of sulphuring was first noted with Experiment 5 of Series 2. In Series 3 definite improvement was noted when the sulphur charge was increased to 12 ounces, the copra appearing whiter, and during the drying remaining freer from moulds than in the case of the control (d), and of a higher standard of quality than any native copra or even that of many European planters. With a reasonable percentage of moisture on the green copra the sulphur fumes (SO_2) not only exercise the desired fungicidal effect but also bleach the copra, thereby adding considerably to the appearance of the dried copra. The difference between the various copra samples of Series 3 was not manifest in the appearance of the copra, all being apparently of the same quality.

(a) *Germinated*.—The copra obtained from the germinated nuts during these experiments received the same attention as (c) and (d), viz., that it received protection from rain and at night, the cover consisting of an open shed or an open garage. This type of copra is invariably thin and when dry becomes very brittle. It is greasier to the touch than copra prepared from the ripe nuts, a feature which is due to the fact that during the process of germination and the successive growth of the young plant the enzyme or enzymes which assist in that process by attacking the endosperm of green copra meat, break down the cellulose tissue and thus release the crude oil. It is this oil that gives the impression of excessive greasiness as compared with copra from ordinary ripe nuts.

In the three experiments allotted to this type of copra, in two cases—Experiments 2 and 7—the copra was definitely of poorer quality and appearance than either of the normal samples as expressed by sulphured (c), or control (d). In the case of Experiment 1, the difference was not sufficient definitely to mark it as below the standard of sulphured (c) or control (d). The conclusion therefore is that the use of germinated nuts for the purpose of copra making tends to lower the quality of the copra produced whether the copra is sun-dried or first sulphured and then sun-dried, and should therefore be avoided. With the proper and regular collection of coconuts throughout the plantations the presence of germinated nuts would be reduced

to a minimum and another cause for the production of poor quality copra removed.

(a) *Uncovered*.—As already explained in the early part of this paper often no protection from the weather is accorded by the native to his copra during the process of curing. A small section of each experiment therefore was set aside under similar conditions and the result noted. One curious feature of this experiment was that as the sulphuring increased in efficiency so this particular copra became more and more charred in appearance and poorer in quality. Further it appeared to become more attractive to the copra beetle (*Necrobia rufipes*). The conclusion to be drawn from this experiment is that sulphuring does not improve copra which is neglected during the drying period. It is possible however that with the man who decides to improve his copra by sulphuring but fails to give that copra reasonable care during the subsequent drying will have the result of his neglect so apparent in the sulphured article as to compel him to give the required attention, and so secure the full benefit of the sulphuring operation to the further improvement of the copra.

Series 4.—The conclusions just arrived at dealt with the first three series of experiments. Series 4 deals with a set of impromptu experiments which, owing to the few nuts available, serve as indications of possible treatments of green copra which might prove of economical importance.

(1) *Sea water*.—It is known that sea water does improve the appearance of copra when quick sun-drying can be effected, but Experiments 9 and 12 suggest that it is more injurious than beneficial to copra when drying conditions are not favourable.

(2) *Potassium metabisulphite* ($K_2S_2O_5$).—The anticipation of automatic fungicidal action by this salt on copra did not mature, the resultant product being badly attacked by moulds and of very poor quality.

(3) *Washing-soda* (Na_2CO_3) and *Caustic soda* ($NaOH$).—The results obtained by the use of these two substances, particularly in Experiments 14 and 15 when after first washing in the solutions, the copra was then sulphured and cured, were startling, the washing-soda (Experiment 14) being slightly ahead of the caustic soda in appearance, but the difference was so slight that in grading they were classified as the same. It was however in storage that difference arose in favour of the washing-soda treatment, for the copra thus treated had, during the $4\frac{1}{2}$ months of storage, resisted all mould and insect attack, and this in the midst of other copra that was badly infested with copra beetle (*Necrobia rufipes*), other insects and moulds. Some of this copra, after 10 months in store, was examined and found to have turned rather yellow in colour and to have sustained some attack by insects. On steeping some of this copra in water for two or three days, the water was examined and found to contain sodium sulphate, suggesting that part of the reaction occurring during the sulphuring process resulted in the formation of this salt which not only acted as a fungicide during drying and in storage, also appeared to have acted as an insecticide for this particular sample (Experiment 14) at the same time. Sodium sulphate is recognised as injurious to certain fungi, e.g., smuts and bunts, so that the result attained here suggests a possible extension of its usefulness.

In conclusion therefore it may be stated that the treatment carried out in Experiment 14, namely, to wash the green copra in a 10 per cent. solution of washing-soda (Na_2CO_3) and then subject it while wet to sulphur fumes seems to offer possibilities for commercial use, its advantages being:—

- (1) facility and cheapness with which washing soda can be obtained;
- (2) the clear and clean appearance and the high quality of the finished product;

- (3) the fact that such treatment by preventing mould and insect attack would conserve the weight of copra and therefore oil produced and exported, to the advantage of the producer; and
- (4) that no complications would arise with reference to machinery, &c., through the presence of minute quantities of sodium sulphate on the copra.

SECTION I—B.

STORAGE.

Introduction.—On completion of the foregoing experiments it was the intention to ship the experimental copra to the Imperial Institute, London, by the first direct boat, and for this reason the weighing of the copra was left until the time of shipment, which was expected to be at an early date. Owing to no boat being available before the writer had to leave Suva, shipment was not made until some five months later. In the following section of this paper therefore the omission to weigh the copra when placing it in store is regretted for it has prevented the obtaining of figures which would have recorded actual losses due to evaporation and insect damage, &c., as well as emphasised the value or otherwise of certain treatments.

Reference to the various indexes available in the Departmental library gives no record of work dealing with the losses incurred by copra during storage. Amongst the records of the Government Chemist, however, were found particulars of storage experiments dealing with losses by evaporation and deterioration through the increase of f.f.a. of the copra, which had been carried out by his predecessor, C. L. Southwell, B.Sc. A copy of this paper is appended so that all available information dealing with these various losses in storage may be placed on record.

On completion of the foregoing experiments the dry copra was sampled and bagged. The method of sampling adopted was that generally known as "quartering," the various types of copra produced being thoroughly mixed and quartered until 3-5 lb of that copra remained. The usual copra bags of commerce were used for bagging both samples and bulk copra. In the case of the former, the large bags were cut into four sections, each section being made into a miniature copra bag capable of holding about 7 lb of copra. The bagged copra was stored by courtesy of Mr. J. P. Farby, Manager of the Government Rice Mill, in the old Customs Shed, Suva. This shed is a wooden structure with the usual corrugated iron roof, but it is used mainly for the storage of rice, for which purpose the floor is covered with a series of wooden gratings made out of 3 in. by 2 in. timber. These gratings allow for air circulation under the rice or copra stack and also help to reduce rat damage. Such gratings are not usual in copra stores in Fiji, and therefore represent the difference in the storage of this copra as against that in the usual commercial store. The copra was placed in this store on March 12, 1930, was examined July, 31 1930, 4½ months later, and shipped to London on August 18th, 1930, for examination, analysis and report by the Imperial Institute, whose report is awaited with interest.

The stores used for copra in Suva by the copra merchants are usually well-built iron or concrete buildings with concrete floors, well ventilated and dry and in close proximity to the wharf. At the small stores owned by Chinese and Indians, scattered throughout these islands, the copra is stored in a wooden or iron shed on either a wooden or earth floor. As the dry copra is brought to these stores by the producer it is weighed and dumped in a heap on the floor of the copra shed, if green copra is brought it is also weighed

and then spread on the storekeeper's vatas, and when more or less dry, transferred to the copra shed and mixed with the copra already there to be bagged when required for shipment. The quality of this copra is invariably poor, due to lack of care and attention given either by the producer and/or storekeeper during drying and storage, for such heaps are usually alive with maggots, weevils, copra beetles, ants, &c. The loss occasioned by the presence of these insects is unknown and must constitute a serious item in the economy of copra production. The condition therefore of the experimental copra tabulated below, is of interest, particularly where such is compared with that which passes through the stores just referred to, viz., those of the Indians and Chinese:—

Expt. No.	Sulphured.			Control. (d)
	(a) Uncovered.	(b) germinated.	(c) Covered.	
1	As (c).	As (c).	Appearance and colour bad. Badly infested with beetles— <i>Necrobia rufipes</i> and <i>Calandra oryzae</i> (?). Lot of frass. Quality bad.	Appearance good, slight browning otherwise as (c). Quality bad.
2	As above, brown discoloration.	As above.	Appearance and colour fair. Badly infested as above. Quality bad.	As above.
3	As (2) above.		As (2) above.	As (2) above.
4	Appearance and colour bad, infestation bad. Quality bad.		Appearance fair, colour good, but infestation bad. Quality bad.	As above.
5	Appearance and colour bad, infestation bad. Quality bad.		Appearance and colour good, Infestation fair. Quality good.	Appearance and colour bad, infestation bad. Quality bad.
6	Appearance and colour fair, but infestation very bad. Quality bad.		Appearance and colour nearly as good as (5). Infestation bad. Quality fair.	Appearance and colour fair. Infestation bad. Quality fair.
7	Appearance and colour bad, infestation bad. Quality bad.	Appearance and colour good, infestation fair. Quality good.	Appearance and colour good, infestation fair. Quality good.	Appearance and colour good, infestation bad. Quality fair.
8	As above. Quality bad.		As above. Quality good.	Appearance and colour bad, infestation very bad. Quality bad.
8A	Appearance and colour fair, infestation very bad. Quality bad.		Appearance and colour very good, infestation fair. Quality good.	As (8) above. Quality bad.
11			As above (8A).	As above (8A).

SERIES 4.

Expt. No.	Washed.			Control.
	Uncovered.	Covered.	Washed and sulphured.	
9	Appearance, colour infestation, very bad. Quality bad.	Appearance and colour fair, infestation bad. Quality bad.		Appearance and colour bad, infestation bad. Quality bad.
12	As (9) above.	As (9) above.		As (9) above.
10		Appearance, colour and infestation, bad. Quality bad.		As (9) above.
13		As (10) above.		As (9) above.
14		Appearance very good colour pearly white, infestation bad. Quality 1st grade.	Appearance and colour excellent. Infestation NIL. Quality extra 1st grade.	Appearance and colour fair, infestation bad. Quality bad.
14A		As (14) above.	As (14) above except slight infestation. Quality practically extra 1st grade.	As (14) above.

Expt.	Washed.		Control.
	Covered.	Washed and sulphured	
15	As 14 above. Quality 1st grade.	As 14 except for very slight infestation. Quality as 14a above.	As 14 above. Quality bad.
15A	Appearance and colour good infestation bad. Quality good.	Appearance and colour good, infestation fair. Quality 1st grade.	As 14 above. Quality bad.

Discussion.—Reference to the above table supports the observation made in Section I of this paper, namely, that an approach to effective sulphuring was first noted in Experiment 5, for in the condition of the copra in store it is the sulphured and protected copra of this experiment that shows to advantage over the control copra, both as regards appearance and infestation by insects, and it is noted that in each of the succeeding experiments of Series 2 and 3, that with the exception of Experiment 6, the sulphured and covered is of better quality—judging by appearance and amount of infestation by insects—than the control samples. The suggestion here is that not only does the process of sulphuring assist in checking undesirable mould growths during drying and storage but that it exercises insecticidal properties also during those periods, particularly in the latter.

In Series 4, however, Experiments 14 and 15, not only achieved the purpose of this series of experiments, but when the washed copra was duly sulphured the dried product was found not only of excellent colour and free

from mould attack, but to have also been immune from insect damage during the $4\frac{1}{2}$ months it was in store whilst still retaining its excellence of colour and freedom from moulds. Of the two experiments named, No. 14—that washed in washing-soda (Na_2CO_3) solution and sulphured—may be considered the most successful because no insect attack was discernable, whilst a slight attack was noted in the case of No. 15, where caustic soda (NaOH) was used. Further, in the case of Experiment 14, this is a more practical proposition from the planters' point of view, washing-soda being readily obtainable, it requires no special containers for transport purposes, and is cheap, whereas caustic soda rapidly deteriorates in humid climates, would require to be packed in special containers, is more expensive and not so easy to handle. The result obtained therefore in Experiment 14 is of importance in that it suggests a possible method of preventing losses due to insects when copra is placed in store.

On examination of this experimental copra, the whole was carefully screened and the frass obtained collected and weighed. Frass is defined, entomologically, as excrement. The frass obtained therefore represented an unknown quantity of destroyed copra, so that the results of the following calculations must be considered only as a rough approximation to the truth, especially as the frass was from two or three insects. In the case in point, 81 lb of frass was recovered from 25 cwt. 3 qrs. 2 lb of copra, equal to a loss of 2.9 per cent. in terms of frass. Assuming, however, that to produce one pound of frass 2 lb of copra were destroyed—quite a conservative estimate—the actual loss of copra in this case would be 5.8 per cent. of the whole, and in view of Experiment 14 would represent an avoidable loss.

03 Further, it will be noted (page 25, Section I) that the control copra of these experiments was generally of better quality than usually produced by the native, so that it is reasonable to assume that the insect damage to this experimental copra was less than it would have been in the case of native copra stored under the usual storekeeper's conditions.

To obtain some idea of what this loss means to the Colony it is estimated that the native produces at least one-third of the Colony's total copra output. The average output for the five years 1926–1930 was 28,500 tons, representing about 9,500 tons of native copra. Using the figure obtained in the storage experiment as representing loss to copra from insect attack, then the loss would be 1,600 tons per annum which at the present price of copra, viz., £9 5s. per ton at Suva, means a monetary loss to the Colony of nearly £15,000 annually.

In conclusion, reference to the *Agriculture Journal* of Fiji, 1930, Vol. 3, No. 2, page 81, will give possible losses to copra in store through mould action. If this is read in conjunction with the present paper, it will be seen that Experiment 14 especially seems to offer a suitable method whereby these enormous losses to both producer and this Colony through the ravages of moulds and insects in copra in store may, with reasonable expectation of success, be averted.

DETERIORATION OF COPRA ON STORAGE.

By C. L. SOUTHALL, B.Sc., former Government Chemist, Fiji.

The experiments carried out during the winter of 1927 to determine the loss caused to copra by drying on open vatas pointed to the fact that further loss occurred after the copra was removed from the vata to storage. To determine, if possible, the conditions resulting in the loss and the amount of loss, the following experiments were made:—

- A—Change in acidity of three commercially prepared samples of copra.
 B—Slow drying on open vatas for 14 days followed by three months' storage.
 C—Storage of commercially prepared copra for three months and estimation of loss at intervals.
 D—Rapid drying of copra on open vatas and removal to storage for three months.

A—Change in acidity on storage.

The loss of copra was unfortunately not determined but nevertheless the results are of interest:—

Copra	23-10-27.		10-12-27.		7-1-28.	
	Water.	f.f.a.	Water.	f.f.a.	Water.	f.f.a.
1	9.1	4.6	4.9	12.2	4.7	11.8
2	7.1	2.9	4.8	4.2	4.7	4.4
3	7.4	2.1	4.8	4.9	4.6	4.9

The copra arrived in Suva on 22nd October, 1927, for shipment to Europe. Sacks of each brand were held back and stored with other copra in a bulk store, being examined at intervals.

B—Changes during slow drying on open vatas for 14 days followed by storage for three months.

This experiment was a continuation of one reported to you on 22nd October (Ref. No. 1190/27). On the 14th day the copra was bagged and stored with other copra:

	Slow drying on open vatas.		Storage in presence of other copra.	
	1st day.	14th day.	55th day.	99th day.
Moisture	45.6	8.0	4.8	4.6
Oil content of anhydrous copra .	68.4	69.9	70.6	70.4
Acid in oil (as oleic)	0.2	6.5	9.9	9.8
Loss anhydrous copra . . . .	....	10.9	14.6	15.0

C—Storage of commercially prepared copra for three months and estimation of loss at intervals.

The copra was taken at random and stored with other copra. Only moisture and loss of copra were determined:—

Copra.	Originally Moisture.	Two months.		Three months.	
		Moisture.	Loss of copra anhydrous.	Moisture.	Loss of copra anhydrous.
1	7.4	4.9	5.1	4.6	5.4
2	6.8	5.1	4.0	4.8	3.9
3	9.3	4.8	8.3	4.6	8.7

D—Rapid drying of copra on open vatas and removal to storage for three months.

This experiment was designed to follow as nearly as possible normal working methods in Fiji. Two sacks of copra were dried as rapidly as weather conditions permitted on an open vata and bagged after four days. They were stored with other copra for three months, being tested once during the interval. The first sample was dried during fair weather and the second sample during bad weather, being rained on on each of the four days:—

Copra No. 1.	Drying.		Storage.	
	1st day.	4th day.	47th day.	89th day.
Moisture	45.9	8.8	4.9	4.6
Oil in anhydrous copra	68.7	68.6	69.4	69.3
Free acid in oil as oleic	0.2	2.0	6.8	6.4
Loss anhydrous copra .. ..	....	1.1	8.9	9.3
<i>Copra No. 2.</i>				
Moisture	45.7	15.2	5.0	4.8
Oil in anhydrous copra	68.4	68.6	73.0	72.6
Free acid in oil as oleic	0.2	3.2	16.4	16.0
Loss anhydrous copra .. ..	....	2.1	20.1	20.8

In all the above experiments allowance must be made for errors. Satisfactory sampling of copra is not easy and no conclusions should be drawn from small discrepancies between the above figures.

Conclusions.—Assuming the tests made to be typical I think the following conclusions may be drawn:—

- (1) copra containing less than 6 per cent. moisture does not deteriorate to any great extent when stored in sacks in bulk;
- (2) copra containing over 6 per cent. moisture when stored under conditions where it only loses moisture slowly, *i.e.*, in a heap of sacks, deteriorates very considerably. A loss up to 20 per cent. anhydrous copra may occur;
- (3) there does not appear to be a simple mathematical relationship between increase in f.f.a. content and loss of copra, although I am of the opinion that the loss of copra is at least equal to the acidity of the oil. In the more normal experiments the proportion of loss of copra to f.f.a. was as 4 to 3.

Acknowledgment.—Thanks are due to Messrs. Brown & Joske for their assistance in the above work.

SECTION II.

By W. J. BLACKIE, M.Sc., A.I.C., Government Chemist.

This portion of the paper deals more particularly with the chemical side of the problem of copra improvement and in a general way embodies experimental confirmation of the results of direct observation discussed in Section I of this paper.

2. In a previous paper (1) mould damage to copra was discussed in detail and some idea was given there of the commercial losses involved in the methods of preparation utilised in Fiji. The experimental results which follow tend to support many of the arguments advanced in (1), more particularly with regard to the preparation of a stable inhibitory superficial medium which would (a) prevent or retard the development of spores during the period of drying, (b) preserve the copra during storage and transit.

3. The meat of the coconut is rich in proteins, carbohydrates and fat. The surface of the meat in relation to the water is much softer than the interior and contains the products of proteolytic and hydrolytic enzymes, contained in the coconut water. The quantity of these materials such as soluble sugars, soluble protein decomposition products, &c., varies with the age of the nut and is richest in the germinating nut. When the nut is opened and the meat spread out to dry there is exposed a superficial nutrient medium and under humid conditions many of these products, more particularly the sugars, absorb water. We thus have a surface ready for spore development. Once germinated on a rich medium the organisms establish themselves and their subsequent development is ensured by the liberation of enzymes which catalyse the decomposition of the meat. The nature and extent of these enzymes was discussed in (1). It is impossible to prevent spores coming in contact with the drying meat, therefore the problem resolves itself into (a) limitation of spore development and from the storage point of view (b) limitation of subsequent mould and insect followed by mould action on the stored copra.

4. The means of attack from the above facts is obvious, also from the theoretical consideration advanced in (1), where the nature of enzymes and enzyme action is discussed in some detail. It was emphasised there the specific nature of enzyme action and its dependence on optimum conditions of hydrogen ion concentration. The amount and extent of enzyme action depends also on the manner of growth of the fungoid body. If this is inhibited in any way then decomposition is not so rapid in spite of the fact that a small quantity of enzyme can catalyse many times its own weight of reaction products. It is also to be realised that optimum conditions are necessary for the development of the spore. These conditions are realised on drying meat unprotected and include hydrogen ion concentration also, but the range for development is much wider than that required for optimum enzyme action. The development of the spore is influenced more particularly by temperature, moisture and sufficiency of food. It is possible that the materials used in this investigation to be described subsequently, may have acted as enzyme inhibitors but this is not considered to be the primary action.

5. It was realised that the methods adopted must be simple, cheap and noticeably effective and that any chemicals used must be non-poisonous, otherwise the process would not be a commercial success with native labour. This naturally limits the field of inquiry from a scientific standpoint.

EXPERIMENTAL.

6. The following sections will be considered in turn:—

- (1) sampling, and analytical methods;
- (2) sulphuring of copra;
- (3) washing of copra with sea water and potassium metabisulphite;
- (4)—(a) washing with sodium carbonate 5 and 10 per cent. solution;
- (b) washing with sodium carbonate followed by sulphuring.

7.—(1) *Sampling and analytical methods.*—It is necessary in investigations such as these to obtain representative samples. This is particularly hard with copra, since it is known that oil, free fatty acid and moisture may vary considerably, even in different portions of the same nut. The haphazard methods usually adopted of removing a pound or two of the material from a sack and using this for the analytical operations would be useless here, in as much as the success of the methods depended upon obtaining representative samples for comparison.

8. The methods adopted by the Malay workers were considered too detailed for our purpose and after reviewing these and other sampling methods it was considered that the usual quartering method as modified by us gave fairly good representative samples. The following procedure was therefore adopted. The whole of the material as prepared in Section I of this paper was spread out on a board and after thorough mixing with a spade was quartered in the usual manner until a quantity of about 2 lb was obtained. This was first of all bottled, but later experiments displayed the fact that it kept better if sewed up in a small bag. Moreover, it more nearly represented commercial conditions in storage. From each piece of copra so obtained three pieces $\frac{3}{8}$ in. in diameter were punched out by means of a metal punch. Each piece so removed was sliced up by means of a razor blade into small portions less than one millimeter in thickness. The material so obtained was further mixed and quartered until a representative sample for analysis was secured. Remarkably concordant results were obtained through sampling in this manner. The analysis was carried out in the usual way except that the moisture was determined in a vacuum oven and the oil determined on this dried material. The oil was extracted in a Soxhlet Extractor after being ground up with sand using petroleum ether as solvent. Owing to the fact that (a) despite extreme care sand and other particles passed into the extraction flasks, (b) the bottoms of the flasks were sometimes covered with a deposit from the boiling water in which the flasks were immersed, (c) under high humidity conditions an extraction flask even although suitably counterpoised presents too big a surface for condensation of moisture during weighing, the following procedure was adopted with success. The oil after extraction was evaporated with recovery of solvent to a small volume, the residue was filtered through a small Whatman filter paper, the flask being washed with successive small quantities of petroleum ether poured through the filter paper. The filtrate was collected in a small weighed platinum basin and after gentle evaporation in the water bath last traces of solvent removed in the vacuum oven. Free fatty acid was determined in the usual way by expression solution in neutral alcohol, and titration with $\frac{N}{10}$ Sodium Hydroxide using Phenolphthalein as indicator.

9.—(2) *Action of sulphur dioxide on copra.*—A large amount of work has been done on the sulphuring of fruits, &c., in order to preserve them. Except for a limited amount of work carried out in the Philippines (2) and elsewhere, little has been done on the sulphuring of copra. Southall (3), a summary of whose work will be included, carried out experiments with interesting results,

but both his work and that of the Philippine workers suffered from incompleteness. It was therefore thought that a thorough investigation of the claims made for sulphuring copra was necessary since sulphur is a cheap product and readily available in Fiji. The plant described in the first section of this paper was therefore constructed and experiments performed as described there, using varying charges of sulphur and varying times of sulphuring.

10. In order to obtain complete comparison samples of untreated copra were subjected to drying along with the treated material. A control was thus obtained and in almost every case distinct controls were used in each experiment. During the earlier work difficulty was encountered with the sulphur combustion, but after several attempts to obtain complete firing, success attended the use of sulphur mixed with coconut husk as described in Section I. With the heavier charges of sulphur and complete combustion the chamber was soon filled with an atmosphere of sulphur dioxide, and after the completion of the experiment the air in the chamber was still charged with a high content of SO_2 . The earlier experiments suffered from incomplete firing and a consequent low percentage of SO_2 in contact with the meat. The trays were constructed and arranged in the chamber to permit of the greatest possible surface of meat coming in contact with the sulphur dioxide charged atmosphere. After sulphuring the copra was dried along with the control and samples were taken, prepared and analysed as described above.

During 1927-28 sulphuring experiments (3) were carried out at Wakaya and Taveuni with a type of chamber similar to that described in Section I of this paper. From the description of the plant as described in the records of this Department it would not appear to have been as suitable as the one used for these experiments, the main features of which were durability, portability and efficiency. Sulphuring was carried out from four to twelve hours with varying quantities of sulphur, not specified. Difficulty was experienced with the combustion, but it was stated that if the sulphur was spread out on a thin plate to a depth of half an inch combustion took place slowly. We could not obtain efficient combustion by this method and therefore adopted the procedure outlined above.

A summary of the experimental results obtained under conditions to be described and the analytical data after preparation and storage for three months is given below.

(1) Copra sun-dried covered at night. The unsulphured meat dried rapidly and was badly burnt, having dried in three days. The sulphured meat remained clear white; burning was absent:—

TABLE I.

	Sulphured when pre- pared.	After 3 months storage.	Unsulphured when pre- pared.	After 3 months storage.
Moisture (per cent.).	6.9	5.4	5.1	4.8
F.F.A. (per cent.) ..	0.17	1.6	1.2	3.4
Oil colour	White.	White.	Light yellow.	Light yellow.
Appearance of copra	White.	White with copra bugs in cracks.	Burnt.	Burnt, very dusty, larvæ and copra bugs.

(2) Two samples sulphured and unsulphured, sun-dried for one day, uncovered for one night to heavy rain, then dried for three days:—

TABLE II.

	Sulphured When pre- pared.	After 3 months storage.	Unsulphured when pre- pared.	After 3 months storage.
Moisture (per cent.).	5.7	5.1	4.9	4.6
F.F.A. (per cent.) ..	0.34	2.0	7.6	8.1
Oil colour	White	White.	Yellow.	Deep yellow.
Appearance of copra	White.	White, but contain- ing copra bugs and larvæ.	Brown mouldy	Brown, copra bugs and larvæ more extensive.

(3) Sulphured and unsulphured sample placed in a damp shed without air drying. Humidity increased by covering with corrugated iron. Each night for eight nights the iron was removed and copra sprinkled with water. After this period the sulphured sample appeared unchanged, the unsulphured a slimy mass of moulds:—

TABLE III.

	Sulphured When pre- pared.	After 3 months storage.	Unsulphured when pre- pared.	After 3 months storage.
Moisture (per cent.).	5.9	5.3	5.1	5.0
F.F.A. (per cent.) ..	0.34	1.79	9.6	11.5
Oil colour	White.	White.	Light brown.	Dark brown.
Appearance of copra	White.	White with larvæ and copra bugs.	Very mouldy and dark.	Dark with more ex- tensive larvæ and copra bugs.

If we summarise these results for the free fatty acid we obtain:—

TABLE IV.

	Sulphured. March—June.		Unsulphured. March—June.	
	%	%	%	%
I	·17	to ·16	1.2	to 3.4
II	·34	to 2.0	7.6	to 8.1
III	·34	to 1.7	9.6	to 11.5

It would therefore appear that sulphuring of copra had much to commend it.

The following are the results of the analyses of the experimental material prepared as described in Section I of this paper. The experiments are more detailed and the results obtained are similar to those described above. In

order to facilitate comparison I have tabulated the results in a manner similar to that in Section I:—

SERIES 1—TABLE V.

Expt. No.	Sample.	Water.	Oil on water free.	F.F.A.
		Per cent.	Per cent.	Per cent.
1	Unsulphured control ..	7.95	67.45	0.88
	Sulphured germinated ..	6.98	68.22	3.29
	Sulphured uncovered ..	8.21	70.54	1.30
2	Sulphured covered ..	8.92	68.44	1.76
	Unsulphured control ..	9.10	63.54	2.37
	Sulphured germinated ..	7.41	65.89	9.75
	Sulphured uncovered ..	8.09	62.93	3.21
	Sulphured covered ..	6.59	67.70	4.31

Note.—The “free fatty acid” figures are expressed as per cent. lauric acid. “Oil on water free” refers to oil on the dry basis.

In this series, the results of which were obtained one month after preparation, it is seen that if anything the control sample is the better with F.F.A. at .88 as in Experiment No. 1 and 2.37 in Experiment No. 2. According to the F.F.A. figure the control in both cases is 100 per cent. better, although the appearance of the copra suggested very little difference. The germinated material in Experiment No. 2 was extremely poor and it would appear that sulphuring under the conditions described has not the ability to arrest enzyme action once it has commenced in the meat of the germinated nut. This would tend to prove the fact that sulphuring is a surface action.

SERIES 2—TABLE VI.

Expt. No.	Sample.	Water.	Oil on water free.	F.F.A.
		Per cent.	Per cent.	Per cent.
3 *	Control	8.16	64.09	1.09
	Sulphured uncovered ..	9.03	73.95	5.03
	Sulphured covered ..	8.27	67.08	2.49
4	Control	6.71	64.4	0.61
	Sulphured uncovered ..	8.16	....	5.44
	Sulphured covered ..	6.76	67.5	0.67
5	Control	5.44	69.20	1.22
	Sulphured covered ..	6.50	64.21	0.42
	Sulphured uncovered ..	7.30	66.29	7.25

The figures for this series were obtained six weeks after preparation of material. In Experiment No. 3 the control would appear to be the best sample. In Experiment No. 4 there is very little difference between the control and sulphured covered, while in Experiment No. 5 the sulphured covered is the best sample, although the control was quite good. It would therefore appear that the chemical evidence bears out the observations made on Series 2 in Section I of the paper.

SERIES 3—TABLE VII.

Expt. No.	Sample.	Water.	Oil on water free.	F.F.A.
		Per cent.	Per cent.	Per cent.
6	Sulphured covered ..	6.50	64.6	0.83
	Sulphured uncovered ..	8.50	69.2	4.37
	Control	5.05	70.3	0.76
7	Germinated	5.8	63.4	0.67
8	Sulphured covered ..	6.11	65.6	2.68
	Sulphured uncovered ..	8.08	66.9	21.39
	Control	10.00	70.1	....
8A	Sulphured covered ..	7.54	69.26	1.00
	Control	7.22	64.8	10.72
	Sulphured covered ..	10.00	68.7	3.94
11	Control	7.22	64.8	10.72

The results for this series were obtained 2½ months to 3 months after preparation and bagging. In Experiment No. 6 of this series the control appears to be every bit as good as the sulphured product, but enzyme action in the germinated sample, experiment No. 7, appears to have been arrested with the production of an excellent sample. The sulphured products in 8A and 11 are much superior chemically to the control when it is considered that Experiment No. 11 was completed three months after the preparation of the material. The water content is high in the sulphured copra in Experiment No. 11 due to the wet conditions under which it was prepared, nevertheless with this high water content mould damage on the basis of the F.F.A. figure is 2.73 times less than the control, with only 7.23 per cent. of water. These figures were re-determined two months later, that is, five months after the preparation of the sample, with the results displayed in Table No. VIII. The control sample had markedly deteriorated during this period. It is therefore seen that the water content on storage has dropped from 10 to 3.93 and by sulphuring the F.F.A. has only increased to 4.22, that is, 7 per cent. increase.

The original intention was to repeat the determinations as obtained above three months afterwards, but pressure of other work forbade this for every case. In any event each series was complete in itself.

In the case of Series 3, determinations were made three months after the material was bagged. Moisture and F.F.A. were re-determined on the more important samples with the following results:

TABLE VIII.

Expt. No.	Nature of sample.	Three months after preparation.		Five months after preparation.	
		Water.	F.F.A.	Water.	F.F.A.
		Per cent.	Per cent.	Per cent.	Per cent.
6	Sulphured covered ..	6.50	0.83	4.06	0.98
	Sulphured uncovered ..	8.50	4.37	4.74	5.36
	Control	5.05	0.76	3.92	1.04
8A	Sulphured covered ..	7.54	1.00	4.23	1.51
	Control	Badly damaged by mould action.			
	Sulphured covered ..	10.00	3.94	3.93	4.22
11	Control	7.22	10.72	Badly attacked by moulds.	

The control in sample No. 6 gave a better figure for F.F.A. (1.04 per cent.) than the condition of the material would suggest, since it was a very inferior looking article. The percentage increase in acidity 18.1 and 36.9 for the sulphured covered and control respectively gives a better indication of the state of the material. The sulphured covered in Experiments Nos. 8A and 11 had increased in per cent. acidity 51 and 7 respectively. So far no mention has been made of the sulphured uncovered material. On consulting the tables above it is seen that this copra, from Experiment No. 3 onwards from the point of view of the F.F.A. figure, is much inferior to either the control or the sulphured covered. The high figure of 21.39 per cent. of free acidity is reached with the sulphured uncovered product, whereas the covered material contained only 2.68 per cent. F.F.A. These results do not strictly compare with those of Southall (3) (see Table III above), since we did not protect the sulphured uncovered product in any way, whereas his material was uncovered for an experimental period and then dried normally. It is thus to be noted that sulphuring does not protect the copra if the latter is uncovered to all weathers. It does, however, assist materially in producing a good grade copra under high humidity conditions if care is taken in protecting against rain and dew falling intermittently on the material during drying operations. The sulphured uncovered product more nearly represents usual quality copra as produced in Fiji. The figures also display the fact that with care a fair grade copra can be produced without sulphuring. Some of the controls above were quite good even after three months storage but it is to be remembered that these controls were protected at all time during drying from the weather. The sulphured product scores over the unsulphured material dried under similar conditions in (a) having a cleaner almost bleached appearance, (b) lasting better on storage, (c) drying to a better grade material under high humidity conditions, (d) being a little less prone to insect attack on storage. It does not, however, in all cases appear to have the same crisp appearance nor is it so easily fractured as a good quality sun-dried sample. It is in fact generally quite leathery and bends rather than fractures. These points are of commercial importance, but the quality of the material outweighs these apparent physical characteristics. The sulphured meat appears also to shrink less on drying and it can contain a higher water content than the unsulphured material without excessive mould action.

With regard to the chemical action of sulphuring, little can be said as yet. The primary action is no doubt the production of an acid surface which inhibits the development of spores. Nevertheless, when spores do develop on the strongly sulphured meat the fungus body does not flourish so well as on untreated meat, also the sulphured product has a greater resistance against mould action on storage, after a period when it can reasonably be considered that surface resistance has ceased. From these observations it would appear that sulphuring has a more deep seated effect on the copra inhibiting internal breakdown and external enzyme action.

It seems almost probable that some type of enzyme inhibitor is produced by the sulphuring of wet meat. It did not appear necessary at the commencement of this work to determine the quantities of sulphur over and above that normally present in the copra, also the type of sulphur compounds, but in the light of the results obtained such an examination would make an interesting contribution to our present knowledge of the process.

In the above experiments the F.F.A. figure was taken as an index of quality rather than the oil figure. The nuts used in the experiments were of all ages, and quartering was not resorted to in setting aside the material

for drying, nor were equal quantities of material set aside so that in any one series the composition of the copra would differ to a greater or lesser extent. This is well displayed in the oil figures obtained. The F.F.A., which is a measure of oil decomposition, would not be so effective.

From the results of these determinations it can be concluded:—

- (1) Sulphuring of copra, using the plant described under the conditions laid down in Section I for Experiments 8 and 11, produced an excellent quality copra.
- (2) After storage for five months the sulphured product was in appearance superior to untreated copra prepared by the usual methods adopted in Fiji.
- (3) On the basis of the F.F.A. figure sulphured copra lasts better on storage and is a commercial article when untreated Fiji copra has materially decomposed.
- (4) If care is taken during drying operations a good quality sun-dried copra can be made without sulphuring, but this does not keep so well on storage. This conclusion is based upon results obtained with our controls, but does not hold for copra as prepared by certain planters in Fiji.
- (5) Sulphured copra uncovered to weather during drying does not resist mould action, but for intermittent showers it lasts better than normal Fiji copra.

(3) *Washing of copra with sea water and potassium metabisulphite.*—In the introduction to this section of the paper it was pointed out in paragraph 4 that when the wet meat is laid out to dry there is exposed to spore action a surface containing soluble carbohydrates and protein hydrolytic products. It was therefore thought by washing the meat before drying that a large amount of these products might be removed and that therefore mould action would be limited to some extent. It has been frequently observed that copra made near the coast, where sea breezes containing salt spray can come in contact with it, has a better appearance than that prepared inland. The obvious conclusion is that the sea air in some way limits mould action. There would appear to be some slight scientific grounds for this conclusion since in a recent paper (H. R. Curran (4)) it has been shown that increase of osmotic pressure of the medium by sodium chloride has a retarding effect on the development of bacterial spores. It was therefore decided to wash copra with sea water and dry it in the usual manner. The following results were obtained:—

TABLE IX.

Expt. No.	Sample.	Water.	Oil on water free.	F.F.A.
9	Control	Per cent. 7.22	Per cent. 64.87	Per cent. 10.72
12	Sea water single wash . .	Rotted through by fungi.		
	Sea water double wash . .	8.18	62.65	3.18

The single washed sample decomposed early, but the double washed material appeared quite good when prepared and lasted longer. It had, however, become almost worthless after five months' storage and much inferior to the control which, as stated above in Table 8, was badly attacked by moulds, copra bugs and larvæ after five months' storage.

It would therefore appear that washing with sea water had no effect in arresting mould action. These experiments were conducted during bad weather and drying took from 14 to 17 days. It would be necessary to repeat this work under better drying conditions.

It was thought that better results might be obtained by washing with potassium metabisulphite. Metabisulphites are considered to be extremely stable non-hygroscopic substances and are unaffected by air. It was realised that this material is expensive and could possibly not be used commercially, but we had found no reference to its use as an enzyme inhibitor. The sample of metabisulphite which we used appeared to be decomposing with the liberation of sulphur dioxide and it was considered that a type of automatic sulphuring might result from its use, especially in contact with drying meat.

The results, however, were extremely unsatisfactory for both the singly and doubly washed materials which were very badly decomposed, soon after preparation. No determinations were made. However, drying took 19 days with the singly washed and 12 days with the doubly washed. These conditions, as with the sea water washed, were abnormal and a better product may have resulted under more normal drying conditions. The work was not continued with at this stage.

(4) *Washing with sodium carbonate 5 and 10 per cent. solution.*—Considering that the primary action with sulphuring is the formation of an acid inhibiting surface it was argued that similar results could be obtained with an alkaline surface. It was also thought that by washing with an alkaline reagent of sufficient strength that the dual purpose of removing nutrient material from the surface of the meat and at the same time creating an alkaline surface would be served. It has been stated by Webb (5) that in equal concentrations of the ions the O.H. ion appears to be relatively more toxic to the spores he studied than H. ions. He used, of course, artificial media. Levine Buchanan and Toulouse (6) have shown that by the addition of sodium chloride, sodium carbonate and sodium phosphate to caustic soda contained in a suitable medium bacteria were killed more rapidly. Therefore it is the caustic soda itself, not the O.H. ions which, by penetrating the cells, caused death. Meyer (7), however, considers that the action is due to the concentration of the hydroxyl ions. It would not appear that the sodium and potassium ions have any effect, although it is pointed out by Marloth (8) that sodium ions in high concentration are toxic.

The copra prepared by washing in 5 and 10 per cent. sodium carbonate solutions as described in Section I were analysed after five months' storage. The material was in splendid condition and the results obtained were as follows:—

TABLE X.

Expt. No.	Sample.	Water.	Oil on water free.	F.F.A.
		Per cent.	Per cent.	Per cent.
14A	Sodium carbonate 5% ..	4.69	63.02	1.19
	Sodium carbonate 10% ..	5.13	64.08	0.98

It is thus seen that 5 per cent. and 10 per cent. carbonate solutions were effective in limiting mould action, the figure 0.98 being very satisfactory for copra of this age. As far as could be seen this material, except for slight discolouration, appeared sound and was classed as first grade.

Some of the material from the 5 per cent. and 10 per cent. carbonate washed, was sulphured. The results obtained were striking and a product was produced that entirely resisted mould action. It had the bleached appearance of sulphured copra and the analytical figures obtained for the 10 per cent. washed and sulphured after five months' storage were as follows: Moisture, 5.09 per cent.; oil on water free, 61.93; F.F.A., 1.42. This product was considered the best obtained and was classed as extra first grade. It had entirely resisted mould action after five months' storage.

As far as the analytical data is concerned the "carbonated sulphured" would not appear to be in any way superior to the unsulphured carbonated, but its appearance is very much better and it showed no mould development after five months' storage.

SUMMARY.

It has been shown (1) that washing copra with 5 and 10 per cent. solutions of sodium carbonate produces good quality material that markedly resisted mould growth, (2) by washing with 10 per cent. sodium carbonate followed by sulphuring a first grade material was obtained which appeared to entirely resist mould action, (3) the sulphured carbonated copra had a better appearance than the carbonated. It also dried well and had the crisp and easily fractured nature of good quality sun-dried.

In attempting to explain the underlining process of the various attempts to produce a mould-free copra one is faced with lack of experimental details. The experiments outlined above were considered more from the commercial aspect than the scientific. Nevertheless, certain facts were adduced which throw a little light on the matter. Fifty grammes of the materials prepared as above were washed with 50 c.c.s. of distilled water 12 months after preparation and a qualitative analyses made of filtrates. Also 20 grammes of the internal material obtained by removing the entire exposed surfaces as completely as possible were also washed with 25 c.c.s. of distilled water and the filtrates qualitatively analysed. The results obtained are as follows:—

TABLE XI.

	Surface washed.				Internal washed.			
	Control.	Sulphured.	Sul Carb.	Carb.	Control.	Sul.	Sul Carb.	Carb.
Carbonate ..	Absent	Absent	Trace	Present	Absent	Absent	Trace	Present
Sulphates ..	Absent	Present	Present	Absent	Absent	Present	Present	Absent
Sulphites ..	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Only small amounts were present, but the substances were definitely recognised. Of the metallic ions only sodium and possibly potassium were recognised. Calcium magnesium aluminium and iron did not appear to be present in sufficient quantities to be recognised. These results are interesting for it seems evident, as pointed out above, that sulphuring is not altogether superficial and the same would apply to the action of sodium carbonate. Quantitative estimations were not made. It appears (1) that in the sulphured product sulphur dioxide permeates the whole of the meat and in solution comes in contact with possibly potassium soluble salts which are known to be present in coconut water, forming potassium sulphite which is oxidised to the sulphate. The exact nature of the reaction is not known except that the sulphate ion is definitely recognised after twelve months' storage; (2) the carbonate ion permeates the meat; (3) sulphate, probably sodium sulphate, is found in the interior of the meat after washing with sodium carbonate and sulphuring.

Taking these rather scanty facts into consideration and from the foregoing discussion under the various sections it seems as if the main actions are:—

- (1) The sulphurous acid acts first in producing a superficial medium of high H. ion concentration which retards development of spores. The S.O_3 ion also acts toxicologically on spores through the inhibition of enzyme action and on a surface of high concentration of salt produced by evaporation spore development may also be decreased by increase of osmotic pressure. The toxicological action is enhanced by oxidation to the sulphate and the keeping power is enhanced by the presence of this toxicological ion within the meat.
- (2) The washing with sodium carbonate produces a superficial medium of high O.H. ion concentration which retards the development of spores. This surface action is greater than with the H. ion concentration produced by sulphurous and sulphuric acid owing to the greater toxicity of the O.H. ion. The presence of sodium carbonate within the meat assists storage, but it is considered that the toxic action of this ion is less than that of the sulphate or sulphite ion and that its chief internal action is the presence of a high O.H. ion concentration. Osmotic pressure may also superficially play its part here.
- (3) The washing with sodium carbonate followed by sulphuring retards development, as described above, but the presence in comparatively high concentration of sodium sulphate gives the product greater resisting power owing to the presence of the highly toxic sodium and sulphate ions.

The difference between the sulphured product and the sulphured carbonated product is one of degree, also the presence of more toxic sodium ion in greater concentration.

It is to be noted here that in the case of "carbonate sulphured" product that all the spores that normally affect copra are prevented from developing.

CONCLUSION.

There are many opinions as to the exact nature of the reactions of fungi to H. and O.H. ions. It is considered by Boeseken and Waterman (9) that the action of the H. ion is to precipitate the negatively charged albumin and lecithin colloids in the cell wall of the spore, and it is possible that the O.H. ion acts similarly by discharging the positively charged colloids. Marloth (8) suggests that "since the proteins in the protoplasm are amphoteric in nature it may also be possible that the influence of the hydrogen and hydroxyl ion is such as to reverse the charge on certain proteins causing a disruption of the protoplasm within the cell." The opinion is also expressed by Marloth (8) with reference to the action of sodium bicarbonate on *penicillium italicum* that the decay of citrus fruit is prevented by the fact that when the spores develop or commence to develop there is present on the rind a surface film of saturated bicarbonate solution which acts on the proteplasm of the thin wall germ tube or at that point on the spore where the wall is thinned for the emergence of the germ tube. This action is probably more important than the osmotic action discussed above, and it is considered that sodium carbonate and sulphate acts in a similar manner, also that the internal action is somewhat similar within the dried meat of the copra.

From these experiments it would appear that washing with sodium sulphate would produce a good grade copra, and experiments will be instituted to prove this point.

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EXAMINATION BY THE IMPERIAL INSTITUTE, LONDON,
REMARKS AND CONCLUSIONS.

Most of the samples had suffered somewhat in appearance owing to insect attack. When allowance has been made for this defect, the following conclusions can be drawn from the results of the examination.

1. *Effect of Sulphuring (Experiments I to VIII—A and XI).*—The best of the sulphured samples dried under cover was No. VIII—A, sulphured and covered, which had been treated with 12 oz. of burning sulphur for nine hours. This sample was a duplicate of No. VIII, sulphured and covered, but was of better appearance.

2. Although No. VIII—A, sulphured and covered, is better than its control, it is not quite equal to the standard of the control to No. III. From this it might be concluded that the sulphuring of the copra before drying had not produced a better product than can be prepared without this pre-treatment.

3. No. VIII—A, sulphured and covered, was treated with as much burning sulphur, and for as long a time as any of the sulphured and covered samples; in fact, its treatment was more severe than any other of such samples, except its duplicate in Experiment VIII. It might therefore be expected that a slight but gradually increasing improvement would be shown by the samples in proportion to the amount of sulphur used and the length of the treatment. Such an improvement is in fact shown in most cases. Where the samples have all received the same amount of burning sulphur, the effect produced by the varying lengths of the treatment is not very apparent.

4. One of the objects of sulphuring the copra before drying is doubtless to prevent the copra from becoming mouldy during drying. Treatment of the material for this purpose would, however, appear to be unnecessary, as none of the controls showed mould.

5. One effect of sulphuring the copra and drying it under cover would appear to be to reduce the acidity of the extracted oil. The effect on the colour of the oil and the meal is not uniform; in some cases the oils from the treated copras are better than those from the control, and in other cases not so good.

6. Any good effect that might be produced by sulphuring is undone by drying the copra uncovered. Sulphured and uncovered samples generally have a poorer appearance and yield an oil with a higher acid value and of poorer colour than those that have been sulphured and dried under cover. It is to be noted, however, that the oil content of the sulphured and uncovered samples is generally slightly higher than that of the control and of the sulphured and covered samples. Many of the sulphured and uncovered samples were mouldy.

7. The three vara samples were rather thinner than the controls, and yielded oils with an acid value slightly higher than that of the oils from the sulphured and covered samples; otherwise they were very similar to the latter samples.

8. *Sea-water (Experiments IX and XII).*—The effect of sea-water does not appear to be as good as that of sulphuring. The double-washed sample was slightly darker both as regards the inner surface and internally than the once-washed sample, and gave a browner oil and a meal of poorer colour.

The once-washed, uncovered sample had a slightly higher oil content than the control or the covered sample, and yielded a foxy-red oil of very high acidity and a meal of poor colour.

9. *Potassium meta-bisulphite* (Experiments X and XIII).—Treatment with meta-bisulphite does not show any advantage over sulphuring. No. XIII, treated with 100 c.c. of solution, was not so good as No. X treated with 60 c.c. of solution, and gave a foxy-red oil of higher acidity and a meal of poorer colour.

10. *Sodium carbonate* (Experiments XIV and XIV—A).—These samples are better than the control and compare very favourably with the sulphured and covered samples of the earlier experiments. Sodium carbonate has the effect of reducing the oil content slightly, and when a sample so treated is sulphured the acid value of the extracted oil is lowered. The sulphured samples are slightly better in appearance than those which were only washed. Varying the amount of carbonate used does not produce any appreciable effect, though the sulphured sample treated with 10 per cent. is slightly better than that treated with only 5 per cent. No. XIV, washed and sulphured, is very slightly better than No. VIII—A, sulphured and covered.

11. *Caustic soda* (Experiments XV and XV—A).—These samples, like those of Experiments XIV and XIV—A, are better in appearance than the control, and compare very favourably with the sulphured and covered samples. They are very similar to those treated with sodium carbonate. In these cases also treatment with alkali has slightly reduced the oil content, and the sulphured samples yielded oils with lower acid values than the control. The sulphured samples are slightly better in appearance than those which were only washed. The sulphured sample, treated with 2½ per cent. solution of caustic soda, is similar to No. XIV washed with 10 per cent. sodium carbonate and sulphured. No. XV—A, washed and sulphured, is very slightly better in appearance than No. VIII—A, sulphured and covered.

12. *General conclusions*.—These experiments show that no advantage is obtained by treating copra, before drying, with sea-water or with potassium meta-bisulphite.

13. Copras treated with alkali and sulphured before drying give better products than the untreated control samples, and the indications are that treatment with the fumes of burning sulphur for nine hours before drying under cover definitely improves the quality of the resulting copra.

14. The control samples and the sulphured samples dried under cover are generally of better appearance than samples of plantation Fiji copra previously examined at the Imperial Institute.

COMMENTS.

1. The above remarks and conclusions bear out in the main the results obtained during this investigation.

2. It is, however, to be understood that a strict comparison of the findings of the Imperial Institute with our results is not possible, owing to the fact that the weather conditions were not fully appreciated.

3. In dealing with the "objects of sulphuring copra" the suggestion is misleading, being based on the fact that the copra in question had an average moisture content of 4 per cent. on examination in London. Such copra does not favour mould growth and the moulds which had developed when moisture was 12 per cent. and over would tend to die out when the copra dried, leaving, where mould colour permitted, a stain to indicate previous infection. Also in paragraph 2 of the summary reference is made to the

fact that although No. VIII—A, sulphured and covered, is better than its control, it is not quite equal to the standard of the control of No. III. It is readily seen that it was essential to have a control in each case, owing to variations in the compositions of the meat (which was made as uniform as possible for each individual series) and drying conditions from experiment to experiment. It is, therefore, not correct from our point of view to compare the control of one experiment with the controls and treated products of other experiments.

4. It has been frequently noted here that very badly decomposed copra has a higher oil figure than one would expect. This was noted during work with regard to the sulphured uncovered (see Tables, Section II), and was referred to by the Imperial Institute in paragraph 6 above. This high oil figure is, however, only apparent and may be due to either a greater selective rate of decomposition of the components other than oil in the copra, with the escape of volatile products, or to products other than oil appearing in the petroleum ether extracts as a result of this decomposition. This point is very interesting, for the oil contents of sulphured uncovered samples appeared to be very much higher than the controls. It would appear from this that the treatment, sulphur di-oxide and excess moisture favoured the selective decomposition of components other than oil in the meat.

5. Paragraphs 10 and 11 of the Remarks and Conclusions dealing with the sodium carbonate and caustic soda treatments make very interesting reading. The Imperial Institute have noted the important point that the acid value of the oil has been lowered by treatment with alkali and sulphuring. This bears out our conclusions obtained many months previous to the Institute's examination and points to the fact that the treatment inhibits in a marked manner the production of f.f.a. from the oil, that is, that mould damage has been reduced to a minimum. It was stated by the Imperial Institute in their detailed report that experiment No. XIV (washed with sodium carbonate 5 per cent. and sulphured) was free from insect attack. This important fact was not mentioned in the conclusions and remarks quoted above. We had certified the sample as free from insect and mould attack on July 21st, 1930 (see Series 4, page 101) and it was again certified as free from insect attack on arrival in London—eight months after bagging. During this long period the sample was in intimate contact with badly infested copra. The estimated loss on storage due to insect damage has been dealt with in Section I—B, page 105, and the suggestion is that the process involved in Experiment XIV deserves investigation on commercial lines. It is encouraging to learn that the "carbonated" samples are better than the controls and also No. XIV, washed with sodium carbonate and sulphured, is slightly better than VIII—A, sulphured and covered.

6. Considering the general conclusions of the Imperial Institute quoted above the comment concerning copra treated with sea-water is only correct for the conditions obtaining during these particular experiments, the controlling factor being the weather.

7. With regard to the time necessary for sulphuring it would appear from the fact stated in Section I, page 103, that nine hours does not appear to be necessary.

8. The statements with regard to the treated samples are in accord with our own, except that in our opinion, considering all available information, including the results obtained by the Imperial Institute with regard to freedom from insect attack and low acid value of extracted oil, that the samples washed with five per cent. sodium carbonate and sulphured is much superior to the other treated material.

9. The report received from the Oil Crushers per the Imperial Institute letter, 0'2295 of the 30th July, 1931, gives further striking confirmation to the findings of this investigation and is given in full below:—

“ With reference to my letter of the 7th July, a report has now been received from the firm of copra brokers. The samples forwarded to them were labelled from A to H and represented the results of the experiments mentioned below:—

A—Control to Exp. III, unsulphured, sundried.

B—Exp. VIIIA, sulphured, covered.

C—Exp. III, sulphured, uncovered.

D—Exp. VII, sulphured vara, covered.

E—Exp. IX, sea water, once washed, covered.

F—Exp. X, Potassium meta-bisulphite.

G—Exp. XIV, Sodium carbonate.

H—Exp. XVA, Sodium hydroxide.

The brokers stated that they had submitted the samples to a firm of oil crushers in London, who reported as follows:—

We have received your letter of last month together with copies of letters to you from the Imperial Institute and also eight samples of Fiji copra. We have examined these samples and the analyses of them from the point of view of the crusher, and make the following observations:—

Samples E and F are about equal to what we know as F.M.S. Plantation Fiji Copra.

Sample C although high in oil content, has its value reduced on account of the very high percentage of F.F.As. in the oil, and this appears to be directly due to leaving it exposed and being uncovered at night.

Of the other samples, D appears to be the most valuable on account of its high oil content.

Samples A, B, G and H are deficient in oil, but are good from the point of view of F.F.As. in the oil and it may be only a coincidence that the low oil content and the low F.F.A. content exist together in these samples. We do not see why the preservative treatment should reduce the oil content of the copra.

It appears to be important to protect the copra from rain and cover it at night, and the use of burning sulphur as a preservative has a good effect.”

COMMENTS.

10. It is mentioned above that Samples A, B, G and H are deficient in oils. We have noted this (see Tables, Section II) as also have the Imperial Institute. It is probably due to the type of copra used, since Sample A above, which was untreated, was also low in oil. We agree with the remarks of the Oil Crushers that there appears to be no reason why the preservative treatment should reduce the oil content. May this also not be due to the fact that decomposition is so limited that we are here really dealing with actual oil content?

11. In conclusion the remark of the Oil Crushers with regard to samples E and F “are about equal to what we know as F.M.S. Plantation Fiji Copra” gives some idea of the type of copra exported from Fiji. We considered these samples to be particularly bad, so much so, that we could not analyse them several months after preparation. It would appear from the remarks made by the Oil Crushers that distinct advances have been made with regard to the preparation of better quality material, having regard to the commercial aspect of the subject.

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AGRICULTURAL JOURNAL

ISSUED QUARTERLY BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 4.]

FOURTH QUARTER, 1931.

[No. 4.

EDITORIAL.

THE present issue completes the volume of the *Journal* for the year 1931. The financial provision in 1932 will only permit the publication of two issues, so that readers are requested to note that the 1932 volume will consist of two copies. An endeavour will be made to circulate information to agriculturists in Fiji by means of multigraphed notes.

Fiji Show and Agricultural Conference.—A comprehensive exhibit was staged by the Department on the occasion of the Fiji Show in October and attracted wide attention. Cinematograph films on agricultural subjects, loaned by the Imperial Institute, London, were displayed in the Health Department section of the Show by courtesy of the Health Exhibit Committee. It is interesting to record that the Show as a whole was very successful. The Fiji Show Association are to be congratulated on their decision to hold this function in spite of the difficult local conditions. It is noteworthy that in spite of the fact that there were no stock exhibits, the number of entries in all classes exceeded that of 1930. It is understood that the financial result is entirely satisfactory.

The Agricultural Conference was opened on October 13th by His Excellency the Governor. Meetings were well attended and keen interest was displayed in the subjects dealt with. A full report of the proceedings will be found in this number.

The Convention of Agricultural Associations was duly formed at an inaugural meeting of delegates on Tuesday, October 27th, 1931, when five out of the seven participating Associations were represented. The affairs of the Convention will be managed by an Executive Committee consisting of the Hon. Sir J. M. Hedstrom, the Hon. Alport Barker, E. Duncan, Esq., J. L. Hunt, Esq., and the Director of Agriculture. The Director of Agriculture was elected President of the Convention. His Excellency the Governor has been pleased to accord recognition to the Convention.

Fruit exports.—The output of bananas is rapidly increasing and in November 14,181 cases were shipped; 16,266 cases were exported during the period December 1st to 16th. The general improvement in quality has been maintained and this, with the more extended use of better cases, renders shipments more attractive than hitherto. Trials are in progress

with a new type of case which while actually of smaller over-all cubic measurement contains the same, or a slightly greater quantity than the standard case at present used. A noteworthy feature of banana production is the increasing quantity now being shipped from outside districts such as Taveuni, Savusavu, Koro, Gau, Moala and Kadavu. The re-establishment of the banana industry in the Sigatoka Valley is proceeding and arrangements have been made to meet the cost of the suckers required by an advance from Government, the repayment of which is guaranteed from Provincial Funds. Similarly, in the Rewa River districts suckers will be provided for those who require them and payment made from the proceeds of the crop. Although the wider area over which the banana-growing industry is now spread renders transport and control of quality more difficult, there is the undoubted advantage that in the event of localised severe storms the output will not be affected to nearly so great an extent as was the case when the production was almost entirely confined to the Rewa River basin.

Referring to the subject of citrus exports which was discussed in *Journal* No. 2 of 1931, it is interesting to observe that Cyprus intends to explore the possibilities of exporting citrus fruits to New Zealand. In the *Cyprus Agricultural Journal* of September, 1931, reference is made to the substantial preference of about 7s. 4d. a case placed by New Zealand on oranges from Empire sources. The fact that a Dependency so far away from New Zealand as Cyprus is should be seriously considering the marketing of fruit in New Zealand should provide a stimulus to growers in Fiji, who are exceptionally favourably situated for that market. The Cyprus authorities are fully aware of the difficulties attending transport for so great a distance and they also have in mind the safeguards enforced by New Zealand against the introduction of fruit-fly. Now that it is known that the fruit-fly can be killed by exposing fruit to a low temperature, there is some prospect of easing the existing regulations. The Department of Agriculture, Cyprus, is apparently in communication with the New Zealand authorities on this subject.

FIJI AGRICULTURAL CONFERENCE.

October 13th and 14th, 1931.

Mr. Barnes, in introducing His Excellency the Governor, said that this was the third occasion on which the Agricultural Conference had been held and that there were a number of interesting papers for discussion, including one new subject which had not hitherto been touched upon. He informed the gathering that last year the Organising Committee had been authorised to carry on its work with the object of endeavouring to form a Convention of Agricultural Associations, a central union as it were of country bodies, which could speak with authority on matters of agricultural interest, and a body which could be regarded by the Government as the channel through which matters of such interest could pass to and from the country districts. Mr. Barnes informed the Conference that the Committee had considered very carefully the requirements of such a body and formulated a draft set of rules which had been circulated, together with an explanatory letter, to the Organisations, both in Suva and the country districts. He intimated that the response had been most gratifying, seven of the Agricultural and similar Associations of the Colony had expressed a desire to become members of the Central Association. Continuing, Mr. Barnes remarked that this Conference would not deal with the work of the Central Association, but would be, as it were, an educational institution which afforded an opportunity of getting together to discuss matters of common interest. He said that His Excellency the Governor had taken a very keen interest in matters of this kind ever since his arrival in the Colony and that his presence to-day showed his continued interest in the objects for which the Conference had been called.

His Excellency, in rising to open the Conference, said that it gave him great pleasure to welcome on behalf of the Government those who had come to the Conference, and in particular those who had come from districts outside Suva. He said he would take the opportunity of thanking the Mayor for so kindly placing the Town Hall at disposal. He remarked that in particular he referred to the people who had come from outside Suva because he regarded it of the greatest importance in a Colony such as this where the Islands were so scattered and communication so difficult, that the people should get together for the discussion of common problems. Agriculture was the essential life of the Colony and therefore it was most important that the agricultural community should meet to consider matters which were continually before them. He remarked that the present day production questions had become extremely acute, and it was essential that the people should improve their methods if they were to market their produce in a better manner. He felt convinced that Fiji could do a lot more in that line and if the people were to do that more they were bound to get a favourable market. He said Fiji had the soil and the climate, and what were wanted were men who were willing to get down to hard work. His Excellency went on to say that the agricultural community must work together to get their goods on the market. He remarked that he had spoken before about Government assistance in planting and grading, and he hoped that the planting community would co-operate in connection with these matters. He did not suppose that Fiji could work up to a high reputation for its produce quickly, but if we could put oranges and other produce on the market with a Govern-

ment guarantee behind them they were bound to find a good market. His Excellency remarked that copra was a product in which he had taken a very keen interest during the last year. He said he had been round the Western Pacific and had examined the copra produced and on his return had called in at Rotuma. He informed the Conference that steps had been taken in the Gilbert and Ellice Islands Colony definitely to prohibit the export of inferior copra. When he went to Rotuma last year he saw the worst copra which he had ever seen. He did not think that such bad copra could be made. Government had taken steps with the full co-operation of the people and the storekeepers, and had sent a Coconut Inspector for the special purpose of helping the people to produce a commodity of better quality. When he called at the Island this year he was astonished to see the extraordinary improvement brought about. His Excellency said that if the people of Fiji worked to a standard of the best and kept at that standard the produce would find a very much better market than it had at present. He remarked that the question of the grading of copra had been under consideration by the Government and that he was now awaiting a report from the Coconut Committee to whom he had referred the grading proposals. He noticed that there were two very interesting papers on the banana question on the Agenda of the Conference. During his visit to the Agricultural Show he had observed two banana cases. One cost less than 2d. more than the other, it was nicely planed and was a much better looking case. In the same way the packing of citrus fruits could be improved and more care taken in the preparation of the fruit for the market. He assumed the planting community that the Government would do all in its power to assist them. He thought that the Colony got very full value for the money which had been spent by the Agricultural Department. He regretted that the Government was unable to make a larger sum available for the extension of Experimental Stations to investigate the growing of plant material, pure line seed, &c. In this connection he wished to express the Government's thanks to Mr. Duncan who had very generously put at the disposal of the Government some land in Bua for the purpose of experimental work, but he was afraid that the present finances would not permit of any definite extension. Mr. Duncan's offer would be kept in view and he hoped that before long something would be accomplished in this direction. In conclusion His Excellency said that he hoped the points he had raised would be brought out during the discussions of the Conference.

Mr. Hunt read his paper "Banana Growing in Fiji" as follows:—

Banana growing in Fiji for some years past has not been considered as a planting proposition by Europeans. The duty imposed by Australia and the lack of good distribution at other markets caused the industry to dwindle to a notable extent.

Planters did not feel inclined to stand up to the extra expenditure of combating the borer and other pests when marketing facilities and distribution were not available so the wastage on European plantations was very great.

It would be well to call attention to the fluctuations which the banana industry has undergone since its inception. The first record dates back to 1877 when 3,100 bunches were exported. Eight years later this number had risen to 277,973 with a further rise by 1890 to 371,417. In 1892 the number was doubled, 799,210 bunches being exported and for many years this constituted a record. In 1893 the output had dropped to half and by 1895 had reached the low water mark of 155,474 bunches.

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From this point a rise with fluctuations set in:—

1897	272,338	bunches.
1900	488,690	„
1902	..	..	..	424,993	„
1905	..	..	..	313,829	„
1910	..	..	..	433,524	„
1911	..	..	..	1,328,670	„
1917	..	..	..	1,653,639	„

which was the largest amount ever shipped from the Colony. In 1918 the quantity fell to 939,974, in 1919 to 520,038 and by 1930 to 165,000, almost as low as the record year of 1895. Duty to Australia was increased from 2s. to 8s. per case in 1921.

Although the importance to Fiji of the banana industry has suffered a severe set back by reason of the prohibitive duty involved on that fruit imported into Australia, the latent possibilities of these Islands in trade expansion for bananas and citrus fruits are such that it is difficult to estimate to what extent it will benefit the Colony when it comes into its own again.

Indications of a revival in the near future are bright. Since the hurricane and floods of 1929 and 1930 have swept Fiji, bananas are showing great promise and coconut planters who have been hard hit by low prices for copra are now planting bananas to a large extent and many others are seeking information as to planting, cultivation, pruning, powdering, cropping, &c., of this most valuable crop so the following may supply the information required.

There is no doubt the wet zone of Fiji is the most suitable for banana production. Planting distances are regulated by the quality of the soil. On rich banana land the distance for the Cavendish variety is 10 ft. by 10 ft. equal to 435 plants to the acre—a suitable distance, even 9 ft. by 9 ft. or less if it is not intended to replant the area: 10 ft. by 10 ft. and 9 ft. by 9 ft. allows of efficient working by implements.

For the tall varieties Veimama and Gros Michel 11 ft. by 11 ft., 12 ft. by 12 ft. and 14 ft. by 14 ft. (according to soil and intention of ultimate use of this soil) between rows allows of the interplanting of permanent trees such as coconuts, citrus fruits or tung oil which remain and reach the productive stage after the banana plantation has produced four to five years' crops.

When good land has been well ploughed and cultivated or virgin bush felled and cleared, line out to the distance decided upon, dig holes 18 in. by 18 in. by 12 in. deep, even larger in virgin land and set the banana sucker or bulb on loose top soil in bottom of hole and fill up same to within three or four inches of the top. The filling of the hole to surface level does not take place until the stool is well and truly established and cultivation between the rows both ways has ceased.

The banana is a surface feeder and no matter how deep you plant the original bulb the stool always works upwards.

To plant deep to obtain better resistance against high winds does not materially assist as the stool gradually rises; but if planted in good friable soil the roots soon penetrate and the stool obtains a very solid grip.

Drainage must be good and efficient. Bananas can stand a heavy rainfall but not wet roots.

The best months to plant are August, September, October, and November. Care must be taken in the selection of plants. The sword or spike suckers are preferred, their leaves are just forming long and narrow and from 2 ft. to 3 ft. high with good bulb-like butts or corms. Examine carefully to see that they are clean and free from borer.

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On a well conducted banana plantation nurseries are established yearly of sufficient extent to provide plants for whatever area has to be planted yearly. These nurseries should be planted out in January when selected plants and stock from them will be ready for planting out in the following August and onwards. In this way there is less risk of borer than there would be if plants are taken from old plantations.

It is advisable to dig out the whole stool from the nursery, divide up and discard any weak looking or leafy suckers and four plants at least should be available from each stool at 7 months old. It would be well to steep all plants before planting into nurseries as directed by Mr. Simmonds as one would then be certain of obtaining plants free of borer.

To obtain good bunches it is necessary to prune, that is remove certain shoots or followers from the parent plant, not by careless digging but by cutting them well under the surface without damaging the parent plant and unless special tools are used, stab the centre of the bulb or corm removed making a circular movement in doing so. An implement, the patented invention of Mr. Chave Morrison, somewhat similar to a small post digging auger was used here when bananas were plentiful and was an excellent tool for pruning purposes. It is unnecessary to prune till parent plant is six months old, or seven months old, unless growth has been excessive. Experience will teach you which suckers to remove. Weak suckers are distinguishable by their poor looks, slender, long and leafy. A good sucker or follower has a nice full round bulb at the butt and tapers to a sharp point before throwing leaves. The most to be left round parent plant would be three and those must be the best, both as regards position round the parent, and age as regards rotation of throwing bunches. Where growth of parent and followers is very strong it is sufficient in first pruning to leave only two followers.

It has been found very difficult in Fiji to prune so as to have stools fruiting when market prices are high, especially with Gros Michels as their natural months for carrying the flush of fruit are January, February and March, and this variety is liable to be killed out by pruning to get it to produce mature fruit in August and September. The Cavendish and Veimama, if properly pruned will carry fruit all the year round, but take longer to mature in the winter months; as the temperature rises, so does the crop improve. In the cool months a period of sixteen weeks elapses between the shooting of the "flower" to the time the bunch is cut, where in the height of summer that period is ten weeks only.

In 9 to 12 months' time under ordinary favourable conditions, the plants of the Cavendish variety are full grown and the flower shoots. Two and a half to three and a half months afterwards the bunch is ready to cut for shipment, three quarters full or slightly over that stage.

When the plantation has reached the bearing stage the flowers or "sobos" start to shoot and these have to be attended to immediately the flower leaves the vertical and is becoming pendant. The man who has charge of the cleaning and powdering must be expert at his work. He starts from the top and removes carefully the sheath covering each hand and keeps on working downwards till he comes to hands which would be too small when ready for market; below this he removes both sheath and hand for several hands and then leaves the balance at end of stalk or stem.

The bunch is then efficiently powdered with insecticide blown in all over the hands and between the fingers to keep off insects, thrips and other pests that immediately attack the bunch.

This cleaning and powdering must be carefully and efficiently done otherwise the whole crop might be ruined, and having brought a plantation

to the bearing stage it is well to see that not a bunch is lost so that the maximum return is obtained. The insecticide is one part *Pryethrum* Roseum and three parts of selected white sifted wood ashes carefully mixed together.

Too much of this mixture should not be made up at a time. Mix only sufficient to do one or two days' work and keep in a closed tin after mixing. It is well on the next day again to look over the flowers or bunches, especially in wet weather. There are many men in Fiji that are quite expert at this work and can efficiently clean up to 120 flowers per day, but it is not advisable to give a cleaner piecework.

The cost of bringing an acre of bananas into bearing without counting the proportionate cost of the planter's house or his upkeep during the period, that is, from the time of clearing the ground and planting till the crop is reaped is £13 to £18 per acre according to the country operated on.

In Fiji the first or plant crop will come into bearing on good soil in 12 months. Marketable bunches have nine hands or over and where the fruit is shipped on the stalk, bunches under nine hands are broken up into hands or fingers as the market requires and the fruit is shipped in cases; the 3-foot double case for New Zealand and the bushel case for the Commonwealth of Australia.

A 3-foot case properly packed in single fingers contains from 80 to 85 lb weight of fruit, and a bushel case if the hands packed therein are not too large, about the same.

An acre of bananas on good soil and free from disease should produce within 15 or 16 months at least one bunch to a stool or plant set out. These figures are conservative but a blow might more or less seriously alter expectations.

The profitable life of a healthy plantation should run from one of plant crop and three or four years of ratoons and on a well organised plantation it is well to replant one-fourth or one-fifth every year so as to keep up regular output.

Under present methods of cultivation it is considered that one man can look after five acres, and one should expect to receive on the plantation from 1s. 6d. to 2s. 6d. per bunch and from 3s. to 5s. per case or even 6s.

The Australian market could absorb enormous quantities of bananas from Fiji if distribution were properly organised. The New Zealand market, although limited, is a growing one, but here again there is scope for large extension, provided transport and handling are cheap and distribution is widened and extended.

Another very large market to be explored is Canada, and the establishment of direct communication with Fiji would be an arrangement mutually beneficial to this Colony and to the Dominion and everything possible should be done to secure it.

To assist the industry it is vital and necessary that freight charges should be reasonable. The present charge of 4s. per case freight from Suva to Auckland will seriously cripple a reviving industry.

Mr. Simmonds read his paper "Pests and Diseases of the Banana in Fiji" as follows:—

Before proceeding to discuss the actual diseases attacking bananas in Fiji I would like to call your attention to the big fluctuations in output of this crop that have occurred since the fruit was first exported. Mr. Hunt has given figures showing how, starting with 3,100 bunches in 1877, the industry had expanded in 15 years to just on 800,000 and then in three more years

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had fallen to the record low crop of 155,000 bunches. So far as I have been able to ascertain this sudden fall was brought about by two causes, a disastrous flood in the Rewa, followed by a severe outbreak of bunchy top in Tailevu.

2. In 1911 another big fluctuation occurred, when the quantity rose from 433,000 to 1,300,000, due to the opening up of large areas on the Rewa. Six years later, the record output of 1,653,000 bunches was reached, which fell, owing to the influenza outbreak, to under the million the following year. This was followed by the Australian strikes and then the duty, leading to the present low figure, and incidentally, to the disappearance, only temporarily it is hoped, of the European grower.

3. Whilst the duties imposed upon Fijian fruit by the Australian Government in 1921 destroyed any hope of the trade recovering the position it held in that market in 1917, the high quality of the bananas shipped from Fiji had won such a good name, that it seems probable that if this country is again able to supply bunch fruit of that grade, it should, despite the duty, be possible still to send a certain quantity profitably to that market.

4. I now propose to consider what were the factors which had put the European grower out of practice and placed the country in the position of being unable to supply either the quantity, or quality, formerly exported. Apart from the closing of the Australian market by a tariff, there is no doubt that irregular and infrequent shipping were the most serious individual difficulties that growers had to contend with. Unless growers have at least a two-weekly service they suffer serious losses due to fruit passing the shipping stage between boats. On the other hand, unless a certain quantity of fruit is available it does not pay shipping to call, so that, when production falls below a certain critical point, the grower has to face further losses due to insufficiently frequent shipping.

5. At the same time the speaker is of opinion that the main factor leading to the abandonment of cultivation by Europeans was the appearance of certain diseases, some undoubtedly introduced, while others first recorded in Fiji may have been of local origin. Of these diseases there are three that stand out prominently, the earliest to appear being bunchy top. This was followed by the introduction, at an unknown date, of the borer *Cosmopolites sordidus* and, about 1913, the obscure condition known as Sigatoka disease, made its appearance. Of these troubles the most universal and disastrous was, in the speaker's opinion, the borer and much of the trouble blamed to the last named disease was probably due, directly or indirectly to this insect. Now that a method has been evolved of dealing with the borer pest it appears that there is again an opening for the European grower and by the use of the careful methods possible under estate conditions, a possibility of not only increasing our present shipments to the New Zealand market, but of also obtaining a profitable return for a percentage of our highest grade fruit in the Australian and Canadian fields.

6. I will now review the diseases of the plant in Fiji, particularly those which have contributed so seriously in bringing about the present low output and describe some experiments carried out by the Department which encourage the hope that the time has now come when it should again be profitable to take up the planting of this crop. It will be noticed that low as the output of 1930 was, it was not so low as that of 1895, only three years after the big export of 800,000 cases. That was, as stated earlier, due to bunchy top and the recovery from that disaster is encouragement that Fiji bananas may again recover from the cumulative effects of borer, Sigatoka disease and shipping troubles.

BUNCHY TOP.

7. This is the oldest disease of bananas in Fiji and, at the time of its appearance, had not been recorded from elsewhere. It reached its maximum about 1894-5, but had been present probably since as far back as 1885. In 1913 the disease appeared in Queensland, it is said having been imported from this country. It was undoubtedly taken from Fiji to Wallis Island and more recently has been reported from Ceylon. Whether the Ceylon disease is identical is as yet uncertain.

8. The origin of the disease in Fiji is very obscure. It has been suggested that it was originally a sugar cane disease which, in Fiji, moved over to bananas. There is, however, no evidence to support this suggestion. A more probable suggestion is that it was imported with an immune strain of suckers about 1885 and then rapidly spread through the non-immune plants. Such importations are known to have taken place about that date from Tanna and elsewhere.

9. *Symptoms.*—The disease is characterised by rosetting or proliferation of the foliage. The leaves become small, erect, brittle and dark in colour and in well-marked cases the plant produces no fruit.

10. *Cause.*—The causal organism is unknown, but the disease, which belongs to the class known as "virus diseases" has been proved to be transmitted from plant to plant through the agency of an aphid, *Pentalonia* sp. Whilst this is the only insect at present known to be capable of spreading the disease it is possible that other sucking insects, such as *Lyciscus* sp. may be proved able to do so. The aphid is not easily found as it generally lives inside the bases of the leaves and similar sheltered situations. Its control by any method of spraying is thus rendered very difficult.

11. *Bunchy top control.*—At the present time bunchy top in Fiji cannot be said to cause very great losses, and the plants seem to possess a considerable degree of resistance or immunity.* Growers are advised to destroy immediately any plant observed to be affected. Before doing this a small quantity of kerosene or kerosene emulsion should be poured into the heart of the plant to kill as many aphids as possible, thus prevent their flying to other plants, and so spreading the disease, and then to dig up the whole and burn it, or dump it out to sea.

NEMATODES.

12. Banana roots in the old experimental station at Nasinu and elsewhere have been found to suffer severely from a species of nematode worm, *Tylenchus* sp. Attacks by this worm lead to a good deal of rot in the small rootlets, allow the introduction of fungi and have been connected with the so-called Sigatoka disease.

BANANA SCAB MOTH (*Nacoleia octosema*.)

13. The larvæ of this moth cause the unsightly scabs often observed upon bananas in this country. The insect is also known from Java, Queensland and Samoa.

14. *Life history.*—*Egg.*—The eggs are laid in small clusters on the back of the small leaf which encloses the shooting spike or on the surface or base of one of the surrounding leaves. They are extremely flattened and very minute, so that a cluster of 9 or 10 eggs has the appearance of a light brown scale, perhaps $\frac{1}{4}$ inch across. The eggs are deposited about the time that the bunch is being thrown, seldom later. The incubation period is very short—about 72 hours—and the young larvæ will be found to have already entered the spike by the time that this has reached the horizontal position.

* It has been found that a small percentage (5-7 per cent.) of plants subjected to the soaking treatment for borer throw bunchy suckers from the eyes, suggesting that the disease is present but latent and that the severe shock of the treatment caused it to develop.

They do this, not by boring in, but by entry at the tip, where the sheath is uncoiling. For this reason they generally reach the terminal hands first and, fortunately, the larger basal hands are less frequently attacked.

15. *Larva*.—The larva is a dirty pinkish caterpillar which feeds between the fingers, generally upon the outer surface, but frequently, when two-thirds grown entering the green fruit and hollowing it out. They make the fruit into a disgusting mess with accumulations of frass, and render it commercially useless, owing to the disfiguring scars where the larvæ have fed.

16. *The pupa*.—The larva spins a frail cocoon, generally between two fingers, within which it pupates. The pupa is light brown in colour and about $\frac{5}{8}$ inch in length.

17. *The adult*.—The adult moth is pale dirty yellow in colour with a few black spots and lines. It is nocturnal in its habits.

18. *Natural enemies*.—In Fiji a single specimen of a Braconid parasite was once bred out of a larva by the speaker, whilst a pupal parasitism of 20 per cent. by a smoky winged Chalcid has been occasionally obtained.

19. Two parasites have been recorded from Queensland, both apparently casual. Some years ago also Leefmans bred a Braconid in Java, from the carva, but the speaker reared upwards of 500 of the moth from various Javanese sources and failed to recover it, so that, this also, is probably only a casual enemy of the pest. In Fiji egg clusters have been found which have been eaten, possibly by an earwig or ladybird.

20. *Artificial control*.—At present the only method of control known is to strip the bunch as early as possible of its bracts, open up the hands and fingers, blowing a mixture of pyrethrum powder and wood ashes (in the proportion of 1-3 in summer and 1-2 in winter) between the fingers. This method is only partially efficient, partly because a good deal of damage is already done before it is possible to clean the bunch and also owing to the difficulty of reaching all parts of the hands. The pyrethrum too is variable in quality and consequently in its action.

21. As the eggs are laid openly it is possible that in the future this may be found the most vulnerable point of attack. Egg parasites may be found; such, however, frequently have very slow powers of dispersal. It may, however, prove possible to train boys to search for the eggs and remove them before they have time to hatch until such time as experiments which are being carried out evolve a spray which will destroy those present and prevent further deposits. In this case all chances of damage to the fruit would be removed.

THRIPS.

22. There is in Fiji a small flower-haunting thrips which may cause a certain amount of corking of the surface of fruits. Its damage is, however, negligible.

FRECKLES.

23. There is in Hawaii a disease of the skin of bananas called freckles, which principally attacks the Cavendish variety. On Taveuni the speaker has seen a number of bunches of this variety showing a dense spotting rather recalling the disease freckles. It does not affect the quality, but only the appearance of the fruit and, up to the present, no work has, in this country, been done upon it.

SIGATOKA DISEASE.

24. The obscure condition known as Sigatoka disease was characterised by a tapering of the head of the plant and premature throwing of the fruit. The bunch was undersized, with small fruit, which ripened prematurely upon being cut. It first appeared in the Sigatoka district and about 1913 seems to have been present on the Rewa. Whether the condition still exists in

the Colony is uncertain, but none has been reported for the past three or four years.

25. Whilst there is little doubt that in a large number of cases what was called Sigatoka disease was really due to severe borer attack, the speaker did see in 1923, in the Sigatoka Valley, certain Gros Michel plants, tapering abruptly and throwing their bunches prematurely which, upon examination were found not to be suffering severely from borer or other macroscopic disease. Like Panama disease, it was the Gros Michel which suffered most severely, the Cavendish showing some resistance from the first. With the almost total disappearance of the Gros Michel the condition seems to have died out and, at the present time, no complaints of premature ripening are being received.

SCALE (*Aspidiotus destructor*.)

26. When this pest first appeared in Fiji it was bananas which suffered most, subsequently, however, coconuts were more heavily attacked and the damage to bananas was not often great. It did, however, lead to compulsory fumigation of all export fruit for Australia, thus imposing additional expense upon shippers.

27. *Control*.—During the early ravages of the pest, and whilst it was still practically confined to bananas, control efforts took the form of spraying with lime sulphur, but with the spread of the insect to coconuts this ceased to be practicable and a number of natural enemies were imported by the Department of Agriculture in order to bring about biological control, very successful results being obtained.

28. In the course of this work six or seven internal parasites were introduced from Tahiti and Java and some six predatory ladybirds from Java and Trinidad. One of these *Cryptognatha nodiceps* from Trinidad has proved most highly efficient and generally speaking this scale causes little anxiety at the present time.

29. Several other scales have been reported from bananas in Fiji, none, however, have been found to be commercially important.

SMALL BANANA WEEVIL (*Polytusmelber borgi*.)

30. This little weevil is almost an exact miniature of the banana borer *Cosmopolites sordidus*, to be discussed next, but is different in its habits, being generally found in the stem of the plant instead of the roots, whilst the early stages seem to be still unknown. In any case it is of no importance as a pest.

BANANA ROOT BORER (*Cosmopolites sordidus*.)

31. An Indian school master recently wrote to the speaker as follows: "The banana root borer is the worst pest of bananas known. Give the life history of the insect and a method of reducing its numbers in the plants." There is little doubt that this statement describes the position in Fiji and in the speaker's opinion, if the borer could be controlled, all the other banana troubles would sink to very minor proportions.

32. *Effect of borer*.—The borer affects the plant in various ways:—

- (1) directly by reducing the size of the bunches. These instead of ranging from 10 to 12 hands fall to 6 or 8 only and such of inferior quality;
- (2) also directly by shortening the life of the estate, reducing it so that at 2½ or 3 years it has the worn-out appearance expected in an old estate of a 5, 7 or even older cultivation.

33. There is also little doubt that it has an indirect effect, weakening the plant, causing it to fall over in high winds and allowing the introduction of fungus and other disease.

They do this, not by boring in, but by entry at the tip, where the sheath is uncoiling. For this reason they generally reach the terminal hands first and, fortunately, the larger basal hands are less frequently attacked.

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33. There is also little doubt that it has an indirect effect, weakening the plant, causing it to fall over in high winds and allowing the introduction of fungus and other disease.

34. The pest is now widely distributed, being found in Java and through the Islands to New Guinea and Queensland, also in the West Indies, most of the Pacific Islands and Natal. Everywhere it has caused serious loss to planters and much thought has been given to methods for its control. Special entomologists have been working on it as a full-time job for some years.

35. *Life history*.—The white oval egg is laid in a groove in the corm of the plant at or just above the surface of the soil and is most difficult to detect. The resulting grub tunnels through the corm, occasionally, in young suckers, attacking the growing eye and causing the death of the plant. This tunnel gradually enlarges as the grub grows and is packed with the frass (excreta) of the grub. When full fed the larva makes its way towards the surface of the corm, but leaves a thin outer section, pupating without forming a cocoon. When, after 10 to 14 days, the adult beetle is ready to emerge it breaks through the thin outer section of the corm and so reaches the surface. It will thus be seen that during the greater portion of its life, the beetle lives within and protected by the corm with only the tiniest connection with the outer air. This renders any method of treatment most difficult, as in the very limited air circulation, no dip or fumigant can, at normal pressure, reach the grub except in a highly diluted condition. In view of this difficulty, efforts were first directed towards some biological method of control and, in 1913, the predatory beetle *Plaesus javanus* was successfully introduced from Java by Jepson. Although successfully introduced the beetle did not bring about any appreciable measure of relief and further work on the subject became necessary. From the end of 1926 up to 1929 a number of experiments were undertaken by the speaker which have been detailed elsewhere. These showed that:—

- (1) whilst flight took place occasionally, it was so seldom that, as a factor in the spread of the pest, it was negligible;
- (2) that the beetle crawled from one plant to another, but even this as a factor in the spread of the pest was not so rapid as usually thought to be the case, clean plants placed alongside heavily infected ones in several cases remaining clean at the end of 12 months.

36. This indicated that infection is almost always due to the presence of eggs or larvæ in the suckers used in establishing a new estate and if clean suckers could be obtained by some method of treatment, it should be possible to plant up land away from any old stools with confidence that the planter would reap a full harvest before the borer entered in sufficient numbers to do appreciable damage. Efforts have therefore been directed towards endeavouring to obtain a method of ensuring that the plants to be used in planting up should be clean, even though derived from infected sources.

37. First experiments were directed towards some fumigation method, carrying the fumigant (in this case carbon di-sulphide) into the borings by creating a vacuum and then releasing the poison. Whilst a considerable measure of success was attained by this method, there were some survivors even at the point when the plants were killed whilst it was doubtful if eggs would be hurt at all.

38. The next series of tests involved soaking the plants for varying periods and at various depths in cold water and by using the method detailed below it was found possible to obtain a full 100 per cent. mortality of borer without irreparable injury to the plant:—

- (1) Good strong suckers must be selected, having one or more undeveloped lateral eyes in addition to the aerial stem.

- (2) These suckers are placed in a tub, punt or other water-tight vessel, with the aerial stem upwards.
- (3) They are then covered with fresh water to a depth of about two inches above the point where the stem joins the corm, leaving the aerial stem fully exposed to the air and light.
- (4) They are left for 21 days, taking care that the water is maintained during the whole of that period at the same level. This is most important.
- (5) After 21 days they are removed and planted out, either in an isolated nursery or in the field.
- (6) It will then be found that they die back to the corm and one of the lateral eyes develops, producing, in 12 months, a bigger and better bunch than would have been the result had the sucker itself grown.

39. In conclusion a few remarks on the relative merits of the different commercial varieties of bananas may prove of interest as the question is often asked "What is the best variety of banana to grow?"

40. There are only three commercial varieties in Fiji, viz., Gros Michel, Veimama and Cavendish. In the West Indies some attention has been given to another variety, Lacatan, and the notes on that fruit are from Wardlaw and McGuire's paper on "Cold Storage of Bananas."

GROS MICHEL.

Advantages.

Not easily damaged in packing.
Favourite in America.
Hands widely separated.
Good colour.

Disadvantages.

Very subject to diseases, such as Sigatoka and Panama.
Slow coming into bearing.
Liable to damage by hurricane.
Flavour of fruit second class.
Difficult to clean bunches.

VEIMAMA.

Resistant to disease.
Good carrying fruit.
Large bunches.

Fruit coarse.
Intermediate in coming into bearing.
More liable to hurricane damage than Cavendish.

CAVENDISH.

Fruit superior, flavour first.
Early fruiting.
Large number to acre.
Disease resistant.
Least liable to hurricane damage.
Easy to clean bunches.
Favourite in Great Britain, Australia and New Zealand.
Good colour, but paler than Gros Michel.

Fruit requires care in packing.
Hands close together, so liable to damage in cleaning.

LACATAN.

Resistant to disease.
Good flavour, first grade, and texture.

This fruit is not present in Fiji.
Shallow rooting.
Unsatisfactory ripening.
Frequently poor colour.
Very easily damaged.

41. It will thus be seen that in a Group like Fiji, subject to hurricanes, the Cavendish has very great advantages over the other commercial varieties, but the fruit requires more careful handling than either Gros Michel or Veimama.

Addenda.—Since this paper was written further work has been done and certain information on bunchy top come to hand, and it is considered advisable to add this now.

Origin of bunchy-top.—Whilst this disease was first recorded from Fiji, there is evidence to show that it was originally imported from elsewhere, probably on an immune strain. The earliest record I now have is 1886 on an estate close to Suva, following an importation of plants, it is thought from Tanna in the New Hebrides. It completely destroyed the estate in a very few months.

Banana Scab Moth (Nacoleia octasema).—Further work has shown that the egg clusters are placed, not only on the small leaf, but upon any of the leaves surrounding the shooting spike and on either surface or at the base, but only whilst the spike is being shot, so far as has at present been observed.

Mr. Witherow, in opening the discussion, said that both Mr. Hunt and Mr. Simmonds had read very interesting papers. Although both the above gentlemen had spoken so optimistically of the industry he was afraid that he must take a more pessimistic view. He said that he would touch on two aspects only—markets and shipping facilities. He remarked that at the present there was only one market to which Fiji could ship bananas and that was Auckland, New Zealand. This market was being supplied with fruit from Fiji, Samoa, Raratonga, the Cook Islands, Norfolk Island and Niue Island, and even Australia was shipping bananas to New Zealand. He understood that shortly there was going to be a direct service from Tonga to Auckland to carry fruit which was now being grown there. He said that if things had been normal in Fiji and we had shipped the usual 15,000 or 20,000 bunches of bananas monthly it would have been disastrous for the shippers. Even with the small shipments which had been made the losses had been serious. Mr. Witherow said that the time had arrived when we must look for another market and the only market that he could see available outside of New Zealand was the Canadian market. Canada, in his opinion, was an important market for all Fiji produce. Mr. Witherow remarked that some years ago a trial shipment of bananas was sent to Vancouver. They were shipped in cold storage and took 28 days on the voyage. Bunches realised an average of 15s. per bunch and the shippers received an excellent profit. His contention was that if bananas would carry for 28 days under such adverse conditions they should carry in good order and condition in proper ventilated ships. At the present time he said there was one ship, the "Tofua," carrying bananas to Auckland and he contended that she was unsuitable for the trade. The "Tofua" took about five days to do the trip to Auckland which should be done in about three days, and invariably arrived with a very large percentage of the fruit ripe or over-ripe which was a big loss to the shippers. He remarked that the "Tofua" had four boilers, but although representations had been made by the shippers personally and also by the Fiji Planters' Association that the fourth boiler should be used, the Union Company had refused to comply with this request, with the result that the fruit was at least 24 hours longer on the voyage than was necessary. He remarked that what was required was a well-ventilated ship running three-weekly services. The four-weekly service was far too long between shipments, especially during the hot months of the year, and resulted in a great loss to the native grower, who every trip picked a lot of immature fruit

because he knew that if the fruit stayed on the trees for another four weeks it would be useless. With a three-weekly service we could ship a good grade of fruit all the year round. Mr. Witherow remarked that Mr. Hunt in his paper had said that there were indications of a great revival in the banana industry. Mr. Witherow said that he could not see eye to eye with him unless a new market was found for the fruit. The New Zealand market was being overdone, shippers would not ship to New Zealand unless they could make a profit. Years ago when Fiji had an extra market in Australia for the fruit, Europeans had thousands of acres under bananas in Vitilevu. To-day he considered that he was quite safe in saying that there was not more than 50 acres under banana cultivation by Europeans. Mr. Witherow concluded by saying that there would be no big revival of the banana industry in spite of the excellent paper which had been read about the control of disease by Mr. Simmonds, until a fresh market had been found for the fruit.

Mr. Barker said that when he was in Vancouver he was taken by the Managing Director of a Cold Storage plant over the works and that there was lying at the wharf a British ship which had been used for carrying bananas from Brazil to London. The voyage took 16 days. Mr. Barker stated that his friend said Fiji bananas could be easily carried to Vancouver and his firm would be prepared to market the bananas not only in Vancouver but also in other places of Western Canada. The railway lines of the C.P.R. and C.N.R. ran to the cool storage rooms so that there would be no difficulty about transporting the bananas from there to any part of Western Canada. He remarked that he thought this should be taken up by the Government. Mr. Barker informed the Conference that this particular firm was willing to put on a shipping service, provided freights could be guaranteed.

Mr. Barnes said that the discussion on the papers had been very short, but very much to the point and that he was particularly interested in the matter raised by Mr. Barker as he had been exploring the possibilities of marketing Fiji produce in Canada. The speaker said that he did not share the pessimism expressed by Mr. Witherow. He had already said that new markets were wanted for Fiji produce and if the people were prepared to supply what was wanted at the price which the people could pay there would be no trouble in finding the markets. Mr. Barnes entirely agreed with Mr. Witherow that the banana shippers had had a thin time. Unfortunately the prices were fixed rather too high, which was a disadvantage from the shippers' point of view. It had been found necessary to call more frequent meetings of the Banana Licence Board which now met from month to month, and in this way was able to pay closer regard to the shippers' and producers' interests. The Fiji banana stood very high in the opinion of the people of New Zealand and they were always prepared to take Fiji bananas in preference to bananas from other places. Mr. Barnes called attention to Mr. Witherow's remark about the Auckland market being over-supplied. There were other towns in the North Island of New Zealand and even in the South Island which had not been touched as far as the marketing of Fiji bananas was concerned. A return of £7 or £8 nett profit per acre as quoted by Mr. Hunt he considered was sufficiently attractive to encourage more people to take up the cultivation of bananas. One important point which had been overlooked during the discussion was the development of a trade in dried bananas. He stated that inquiries had been received and he shortly hoped to make an announcement about this matter not only with regard to bananas but also the likelihood of marketing fresh pineapples.

Mr. Matthews drew attention to the fact that about twelve months ago in Auckland bananas were being retailed at 8d. to 1s. per dozen.

Major Willoughby Tottenham raised a point in connection with the railway freight on bananas in New Zealand. He said that he understood the Fiji bananas were charged at a much higher rate than New Zealand fruit railed from town to town.

Mr. Witherow said that he would like to supplement his remarks by stating that the freight on bananas to New Zealand was 4s. per case, a voyage of 1,200 miles. This freight worked out at about £4 per ton, which he thought was the dearest freight in the world.

Mr. Mander called attention to *Mr. Witherow's* remarks about the unsuitability of the "Tofua" for carrying bananas. He remarked that the "Tofua" had been carrying bananas for the last 20 years and from records in his office it was evident that the shipments arrived in Auckland in good condition. With regard to the freight on bananas *Mr. Mander* said that during the last ten months his Company had lost £12,000 on the running of the "Tofua."

Mr. Fernandez said that the information given about the freight on bananas from Fiji to Auckland was very interesting and quoted the fact that the Rewa Co-operative Dairy Company Limited paid 3s. 9d. per box freight on butter from Suva to Auckland, whereas from Auckland to London the freight was only 3s. 6d. He said that about eight or ten years ago the freight from Suva to Auckland was 1s. 10d. per case.

Mr. Hathaway spoke about the improvement of banana cases.

His Excellency said that all had listened with much interest to the papers of *Mr. Hunt* and *Mr. Simmonds* and the discussions had been very illuminating. He said that he was pleased to hear a little pessimism from *Mr. Witherow* which he was certain could be overcome. The question of new markets had been continually before the Government for sometime past and last year arrangements had been made for the Director of Agriculture to attend a Conference at Honolulu which was, however, postponed. Government would consider asking him to go further afield to investigate markets for Fiji produce. His Excellency mentioned Jamaica which had been properly organised and now had ships running to London with fruit. The Shipping Companies were passing through a particularly difficult time and they required our sympathy just as much as the planting community did. In conclusion His Excellency thanked *Mr. Hunt* and *Mr. Simmonds* for their very useful papers.

Mr. Turbet read his paper "The Stock Industry with reference to the Export of Beef" as follows:—

For many years the growing cattle industry of Fiji has languished for want of sufficient markets in which to dispose of our inevitable increase. The future development of our beef cattle raising industry is thus dependent on the establishment of an overseas market. There appear to be prospects of such a market in Hawaii, part of the territory of the United States of America and also on the mainland of the United States. With a view to sharing in this market an effort was made by a local breeder about two years ago to arrange for a shipment of carcase beef to United States territory. He had not, however, ascertained the conditions governing the importation of meat into the United States and at the last minute it was found that the United States territories would not accept meat from Fiji, this country not being included in the list of countries from which meat could be imported.

The United States Secretary for Agriculture has ruled that no meat or meat products shall be imported into the United States from any country which does not maintain a system of meat inspection which is substantially equivalent to that of the United States, and, further, that meat and meat-food products are ineligible for importation into the United States under the present regulations of Fiji as they do not provide for veterinary ante-mortem and post-mortem inspection, the disposal of diseased meat, the re-inspection of meat and meat-food products, labelling, the use of preservatives and dyes and adequate sanitation.

In view of this ruling it became apparent that if Fiji wished to export meat she must be furnished with adequate regulations. Now, the United States regulations are contained in a substantial volume of over 100 pages, and at first sight it would appear an impossible task to draw up regulations substantially equivalent to those of the United States without producing something almost equally voluminous.

The regulations of the Central Board of Health had already been submitted to the United States authorities and turned down, and to patch these up to meet the requirements of the United States would have been comparable to the solving of a very difficult cross-word puzzle. As a guide therefore recourse was made to the Meat Export Regulations of the Commonwealth of Australia. As the title signifies they deal expressly with the export of meat and we know them to be acceptable to the United States authorities. With few modifications these regulations have been adapted to our requirements. They are too voluminous to read through now, but I understand that those interested will have an opportunity of perusing the draft regulations.

In support of the title of this paper I would now put before you my ideas of the essentials for successful meat export.

Quality.—Methods of slaughter, dressing of the carcase and transportation have an important bearing on quality. These factors are immediately controllable and can be thus altered to effect improvement at any time—more difficult factors to control are uniformity of type and early maturity. These take years of careful breeding. Good feeding is essential to the production of exportable beef.

It is generally accepted that Fiji is unusually well suited to the production of beef cattle. This is manifested by the quality and size of our cattle. People who have travelled widely say that they more than compare with cattle of other tropical countries. The average dressed weight of cattle slaughtered in the Philippines, for instance, is 110 kilos, equal to 242 lb as compared with 550 lb in Fiji. There is little difference in fact between the average beef cattle of Fiji and those of New Zealand or Australia.

The above remarks, of course, refer only to cattle actually slaughtered, but since the potential production in Fiji is considerably greater than the demand for local consumption, only the best of the beef cattle supply finds its way to the registered slaughter-houses. There are many more cattle unfit for slaughter owing to poor condition. Lack of condition or quality in Fiji cattle is as a rule not due so much to bad breeding as bad feeding. This latter fault is more the result of overstocking than actual poorness of pasture. Lack of markets in many districts, particularly Taveuni and Vanualevu, has prevented owners from disposing of their natural increase, resulting in many instances in overstocking of available pasture. The animals held on many of these properties would thus not be immediately available for export. The export beef would come from more conveniently situated river-flat pastures which have not been overstocked. A more rapid

turnover of these stock should result. The remoter cattle breeders might then commence to find a more ready local market in filling the gaps caused by the slaughter for export of cattle from those lands more conveniently situated.

The class of cattle required by America is tending more and more to that referred to as "baby beef," which is generally killed between one year and two years old, weighing (live weight) up to 1,100 lb. These animals are the progeny of early maturing stock, raised on the mother and, after weaning, fed with concentrates so that the growth and fattening has been unchecked. The beef cattle raising industry in this country is not yet sufficiently developed to produce "baby beef." The best that can be produced are steers, castrated early, raised with their mothers and grazed on good river-flat pastures not overstocked, so that they reach their prime at about five years old without any setback.

This is the only class of beef which should be considered for export and would be unacceptable unless fat, of uniform size and good conformation. The conformation should be uniform throughout the carcasses of any particular shipment so that there is no disparity for instance between sizes of fore and hind quarters. When hung for inspection for purchase at their destination they should appear as neat and trim as a line of well sized and dressed soldiers.

The meat from such beasts would be, I am sure, acceptable to the American public. It would, however, be fatal to future trade to ship carcasses of mixed sizes, conformation and inferior quality.

The carcass from the large, long-legged, big-framed, aged bullock is not popular in America. The greatest demand is for beef in the retail trade and American housewives are very judicious in this matter, requiring a small family joint which must be of good quality. The types of cattle producing meat of this class are plentiful in the United States of America and exporting countries have made some advancement towards the production of early maturing beef suitable for export, mainly by the importation and use of bulls of early maturing strains.

When stock are held too long in transit or at the slaughter-house paddocks on poor feed before slaughter, there is a resulting loss of condition at the last moment, reflecting in the quality and weight of the carcass. Care should also be taken to avoid knocking and bruising—in this respect the suitability of hornless cattle for the export market is noteworthy.

Beef cattle intended for export should be quiet and accustomed to being driven. They should be handled quietly and capably to prevent restlessness, injury and subsequent loss of condition.

On arrival at the slaughter-house after a tedious journey cattle should be rested in good paddocks for 24 hours prior to slaughter. If the weather is hot, cold shower baths immediately before slaughter improves the meat.

In bleeding, sufficient time should be allowed for proper bleeding. If this point is neglected the meat is subject to earlier deterioration from putrefactive processes owing to the veins containing blood clots.

The spinal column must be sawn, not chopped, in dividing the carcass.

Avoid the excessive use of water on the carcass; a warm, damp cloth should be used for wiping down.

Supply.—It is recommended that with a view to the export trade intending exporters should, wherever possible, set aside some of their better class land for the sole production of export beef care being taken not to spoil the potential productivity of the soil by overstocking.

A continuity of supply in the event of the export of meat being attempted is necessary to keep Fiji beef before the public of the importing country in order to obtain the readiest sale and best prices.

Although Fiji has a comparatively large cattle population it is doubtful whether any large number of the right class could be brought together at an early date for export. Three hundred head would probably be our limit for the first year, with a possible building up of the number of exportable beasts to 2,000 per annum in a few years.

Market.—Although the United States of America is the greatest beef cattle producing country in the world there was a decline in the number of beef cattle to the extent of 10,700,000 or 24 per cent. of the total between 1921 and 1927. The vast population of meat eaters in that country (123 millions) is causing a great drain on the beef cattle population and as a result 70 per cent. of the cattle slaughtered are hand-fed and forced for early maturity. This, of course, adds to the cost of production. It is unlikely that production will ever catch up to consumption and it is estimated that the United States will require more and more imported beef.

Hawaii is a part of United States territory and the same remarks apply. It is to Hawaii rather than to the mainland that the anticipated meat export would be made.

Except as ships' stores no other outside market for Fiji meat can be foreseen.

The re-opening of the meat-canning industry might lead to the exploitation of the other Pacific Island groups as a market for canned beef. The purchasing power of these groups, however, is dependent on a good price being obtained for copra. Until that improves there is practically no export for canned beef.

Slaughter-houses.—Properly equipped slaughter-houses are required according to the specifications set out in the proposed Meat Export Regulations. As far as Fiji is concerned very little is needed in the way of improvements to make the existing slaughter-houses comply, but nevertheless some improvements are necessary.

Cold storage.—Where cold storage is not available at the slaughtering premises it is essential that it be available at a reasonably accessible distance. This is the state of affairs existing here. Some cold storage space is available at the premises of two local butcheries and it can be considered as reasonably accessible.

The essentials required of these refrigerators are that they have sufficient capacity and are capable of reducing the temperature of quarters of carcasses to at least 16 degrees F. in not longer than 24 hours. Meat must be frozen rapidly, that is, within the above mentioned time. There is then little, if any, bursting of muscle fibres or change in structure. Freezing should not commence until the body heat has left the carcass. Precooling therefore must be provided for. This is done by exposing the carcass, for from twelve to twenty-four hours after slaughter and dressing, to a current of pure cold air.

It has been assumed that the method of refrigeration would be the frozen meat system, mainly because our neighbours, New Zealand and Australia, adopt that system and ships are equipped for it. Since, however, Hawaii is only a fortnight away it would be possible to send chilled meat to that country. Under this system the meat is kept at a temperature of from 28 degrees F. to 30 degrees F. This is just below the freezing point of water. The meat arrives at its destination soft and is ready for immediate consumption. Chilled meat is preferred to frozen meat by the public. It

cannot, however, be kept for longer than five to six weeks. If it can be arranged with shipping companies that method would be found more economical in refrigeration and more profitable in returns.

Land transport.—The distances and time occupied in land transport are short, therefore no elaborate vehicles are necessary. They must, however, comply with the standard of sanitation required by an Inspector under the proposed regulations.

Sea transport.—The export of meat is impossible unless shipping companies are prepared to supply cold storage space. Difficulty might be experienced in arranging this. It is unlikely that the ships' people would be prepared to open their cold storage holds to receive a few carcasses only. If sufficiently large shipments can be got together at one time to fill a compartment it is more likely to be well received as cargo, and incidentally should attract more attention when offered for sale at its destination.

The shipping companies must carry the meat in a satisfactory manner as regards stowage, maintenance of an even temperature and general cleanliness. As, however, they are used to the trade and equipped for it, it is not anticipated that there would be any undue risk of loss or damage whilst in transit by sea.

The transport of carcasses from cold storage to ships' side and actual loading should be well planned so that the whole process is done without delay. This is necessary to prevent serious rise in temperature of the carcasses.

Regulations.—It is obvious that certain standards must be adopted to control the industry but more particularly so in the production of such a perishable article as meat. To do this, in the case of meat intended for export, "Meat Export Regulations" are adopted. Countries which buy the meat demand regulations substantially the same as those in force in their own meat industry.

Regulations ensure protection to the producer, the country of origin as a whole and to the consumer. The producer is protected from fraud by the elimination of argument which might possibly arise as to whether a certain carcass was fit or not for consumption and thus passed for consumption or destroyed. The country of origin has a reputation at stake and regulations ensure that all meat passed for export will be marketed to the satisfaction of the producer in the exporting country and to the consumer in the importing country. Certain standards must be conformed with in dressing the carcass and preparing it for export. It must be sound, wholesome and free from disease. The carcass must be uniformly and neatly dressed and not be mutilated in any way. It must be of good shape, colour and be firm. There must be no deterioration between the time of inspection at the slaughterhouse and delivery to the consumer. Re-inspection at the shipping port is provided for. A carcass, passed for export by the Inspector at the slaughterhouse may be withdrawn from export on re-inspection at any time before shipment, should it show deterioration. In brief, if the meat offered for export does not meet the approval of the consumer there will be no export.

As far as the consumer is concerned goodness or badness may be obvious or concealed. The part of the regulations which protect the country of origin will ensure that the meat is outwardly good. Without the backing of regulations, however, there is no guarantee to the consumer that the meat is free from harmful properties in spite of good appearance. The Certificate of the Inspector of Meat under the export regulations, therefore, becomes the hall-mark.

The Meat Inspector.—All countries of any importance require that imported meat shall be accompanied by a certificate of ante- and post-mortem meat inspection by a qualified veterinarian. The duties and powers of the Inspector are very wide. From the yarding of the cattle to the stowage of the carcasses in the hold of the ship the process is under the supervision of the Inspector. The live animal must pass ante-mortem inspection in regard to disease, condition and quality. This inspection is continued to post-mortem and the whole handling of the carcass must be according to the requirements of the Inspector acting under the regulations. Refrigeration, transport and shipping are also under his observation, and, in addition, the carcass is subject to re-inspection at any time and must be so re-inspected before shipment.

It is essential that there must be available at least one qualified Government veterinarian at Suva for this work.

It will be seen that of the factors for a meat export trade discussed in this paper some are variable according to the energies of local producers whilst others are more or less fixed but subject to variation by advancement of scientific knowledge of general application. Among the variable factors are quality, supply and market. Having established a market, development will depend on improvement in quality and supply. Following that, my opinion is that if we have the goods the market will absorb them. The fixed factors are slaughter-house control and construction, refrigeration and transport.

Conference adjourned until 9.30 a.m. on Wednesday, 14th October, 1931.

Wednesday, 14th October, 1931.

Mr. E. Duncan in-rising to open the discussion on Mr. Turbet's paper, "The Stock Industry with reference to the Export of Beef," said that export production at world's prices must be the basis of the development of Fiji. He remarked that development for local consumption would never be successful, as it merely took money from one pocket and put it in another in the Colony and was restricted by the increase of the population of the Colony—a method of development much too slow ever to bring about the cultivation of the spare lands of Fiji or any worthwhile proportion of them within our lifetime. The primary producers of Fiji should be placed in the position to compete in the world's markets and that could only be brought about by reducing our costs of production in every possible direction. Another question bound up with the establishment of the meat export business was the conveyance of livestock at low rates of freight from outside islands to Suva. At the moment there was only one vessel in the Group capable of carrying cattle across the Koro Sea, namely, the subsidised steamer "Malake," and cattle freights by that vessel were practically prohibitive. He mentioned that a fat pig which would kill 200 lb dressed weight cost 4s. in freight from Taveuni to Suva, whilst a fat bullock which would kill 400 lb dressed weight or less cost 30s. for freight charges. Mr. Duncan said that not many years ago Taveuni supplied the major part of Suva's cattle requirements. The nucleus of the herds still existed on Taveuni and other islands, and production could be rapidly recovered—even exceeded—given facilities of cheap and proper transport to Suva or factory. He considered that such a factory under joint Government and producers' control would be successful if the necessary support were given by Government. Mr. Duncan thought that the Colony generally would be much better served by the development of an industry so old and successfully tried out in almost all parts of the Colony,

and for which such large tracts of land in the wet and moderately wet districts of the Colony were so eminently suitable, and which was really a non-tropical or white man's sphere of production and income at present than by embarking on new and extremely doubtful and strictly circumscribed industries such as the people were constantly hearing about. Mr. Duncan hoped that the papers and discussions on cattle raising and beef production would lead to early, real and profitable results to the cattle grower particularly, and also the Colony generally. It was his opinion that if earnestly, systematically, scientifically and promptly followed up, and having assured markets for all its products, the cattle industry would soon—after sugar and coconuts—be the biggest industry in the Colony and a solid and prosperous contributor to its development and finance, provided always that the Government was reasonably helpful. In conclusion Mr. Duncan said that he would like to emphasise that cattle were a necessary supplement to a well-managed copra estate. They saved much hand weeding and brought in a certain amount of income through sale to Fijians and always provided good beef for estate use. In fact, they were a sort of by-product on a coconut estate, and for that reason alone could be produced profitably in competition with any purely cattle-raising venture.

Mr. Bayly remarked that the opening speaker, Mr. Turbet, had said that there was one shipper who had endeavoured to ship meat to Honolulu without ascertaining the requirements of the American Government in regard to the importation of beef into that country. He said that the Company he was interested in had been endeavouring for the last two years, with the co-operation of the American Consul to ascertain the requirements of the U.S.A. Government. He also referred to Mr. Turbet's remarks about the bulkiness of the regulations and said that he had suggested to the Government that this should not necessarily delay the framing of the regulations and that the real work fell on the person desiring to export the beef. Two years had gone by before Government announced that the proposed regulations were being drafted. He quoted from a letter from a Firm in Honolulu to the effect that it would be very difficult at the present day to work up a trade with Honolulu as the Army and Navy had decreed that all beef and, in fact, all commodities required were to be of domestic manufacture, that is, the product of the U.S.A., and he doubted very much if it would be possible to open a market in the U.S.A. territory. Mr. Bayly said that in the opening address it was stated that breeding was more or less subsidiary to feeding. He thought that it was recognised by all people interested in the production of cattle that feeding was an important matter, but the question of breeding could not be overlooked. He said that for the past ten years the men who had imported good strains of breeding cattle could be counted on the fingers of one hand, and that before we could hope to compete in the world's markets we must improve our cattle. With regard to the marketing of baby beef he informed the Conference that his Company had marketed cattle sometimes a little over three years old and they weighed 600 pounds dressed weight. This was done in face of the difficulties of bad roads and transport facilities which may reduce the weight of a beast by 50 to 100 pounds by the time it reached the slaughter-house. He considered that the stock industry was looked upon as the Cinderella industry of the Colony and whenever he wanted a piece of land it was given to him with a certain amount of unwillingness. He again referred to Mr. Turbet's paper in connection with the statement that the best stock was raised on river-flats. He informed the Conference that this cost a great deal more than hill-land and that his Company for one could not afford to have cows and calves on such land. He

did not think for one moment that any man thinking of going into the cattle industry could breed stock on rich river-flats. He then touched upon the question of fencing. In Australia the agriculturists had to look after their fences, but in Fiji the man who was engaged in the raising of cattle had to do the work in connection with fencing his stock. He said that there were no recognised stock routes in the Colony and whenever drovers of cattle had to camp for the night they had sometimes to pay for the water from passing streams. He remarked that he had seen natives who knew that cattle would be driven along a certain road plant up an area of about four chains by half a chain wide hoping always that cattle would pass that way and they would be able to claim damages for their crops. Another difficulty was the tenure of land. At the present time there was a 99 years' agricultural lease, but pastoral leases were for 21 years with an option of renewal for another 21 years. Looking to the future development of the Colony we were forced to the conclusion that if there was to be real development in the stock industry the land tenure would have to be altered. He said that there were thousands and thousands of areas of land in the Colony which were suitable for pastoral pursuits. Two points had been brought before the Conference; one was that Fiji could produce beef of an excellent quality and the other was that we lacked the market in which to sell that beef. He remarked that there was no doubt that at the present time we had not enough beef for export and too much for local consumption, and that before we could enter the world's market we must be in a position not only to produce beef of good quality but also to have continuity of supply. In other beef-raising countries such as the Argentine, South Africa and Queensland there were large tracts of country where the wildest of cattle could be handled with ease by trained men on horses and no fencing was required beyond a few mustering paddocks and sheds at the central station. Every now and then a muster was held and the stock-owners obeyed the unwritten law that unbranded bullocks belonged to the man who had his brand on the mother with which the calves were running. In this way one could produce beef with a minimum of cost, but in Fiji we found that there were innumerable gulleys in the hills and that in an area of 50,000 acres there would not be one single flat area of 50 acres. Cattle which got into these gulleys were very difficult to get out and even sending dogs in after them was useless. The cattle which had wandered into these gulleys generally had to be shot. It meant that fences had to be erected and these fences had to be kept in repair which was a very costly process and required a large outlay of capital and also incidental expense. Another difficulty confronting the stock raisers in Fiji was the lack of suitable grasses. Turning back to the question of land tenure, Mr. Bayly said that his Company had a 21 years lease of certain land and 11 years of that time had expired. He considered that his Company was just on the threshold of the meat industry and that it was necessary to think about an extension. He was endeavouring to improve his cattle by the importation of pure stock and even with set-backs there was always the chance of improvement but it took time. In another ten years he might find himself faced with the expiration of his lease, in which case there would be nothing left for him to do but to slaughter his herd for the value of the hides and tallow. Mr. Bayly went on to say that the question of markets was the most important one that affected the stock industry to-day and he stated without commitment that the Company he was interested in was prepared to erect a cannery for a capacity of 3,000 head per annum provided that they got the assistance from the Government relative to long tenure and also a protective tariff system in the market. He said that he made this statement in all seriousness. In concluding Mr. Bayly referred to the excessive amount of cattle stealing which went on in

the Colony. Every assize at Lautoka there was one or more cases of cattle and horse stealing and he thought that this could be accounted for by the fact that the Branding Ordinance was not enforced. Most of the cases of cattle stealing were Indians, but in some cases Europeans had been guilty. He said that the cattle of Fiji ran into tens of thousands and he was quite sure that less than 100 carried their registered brand. He remarked that for a good many years the ear-mark had been recognised as the mode of ownership, but he considered that the ear-mark was only useful for different ages of cattle and for identification the cattle raisers were dependant on the fire-brand. He said that he had endeavoured to place before the Conference some of the trials and troubles which faced the stock-raising industry and he would advise any person who was thinking of going into the cattle-raising business to be sure and look after his fences and not to let his cattle get out of control. If he did this he might as well write them off as valueless.

His Excellency said that he had been very interested in the remarks of Mr. Bayly and that the points raised by him would be carefully considered. He assured Mr. Bayly that Government would assist in every possible way. He remarked that he had lately returned from a tour of the Western Pacific and had ascertained that a large quantity of beef was consumed in those Islands. He said that some effort would be made to give a British preference tariff in these Islands which might perhaps assist Fiji in disposing of the surplus meat produced in the Colony. With regard to the question of leases *His Excellency* remarked that he would investigate this matter.

Mr. Barnes said that the question of the export of beef was not a matter that could be dealt with quickly and he fully sympathized with Mr. Bayly. Voluminous correspondence had been constantly passing in connection with this matter and he could assure the Conference that inquiries had been conducted with the utmost despatch since the matter was first raised in 1929. Various attempts had been made to alter the local regulations in order to meet the requirements of the principal meat importing countries of the world. In this connection the Department of Agriculture had in mind not only the territory of the U.S.A. but also countries of the British Empire which might, were shipping facilities available, be able to take a portion of our output. Copies of the Australian Meat Export Regulations had been obtained and adapted to local requirements. He had the permission of the Governor to submit these draft regulations to the Conference before they were approved by Government. He could assure Mr. Bayly by direction of *His Excellency* the Governor that the matters that had been discussed would receive every consideration.

Mr. Turbet said that he would support Mr. Duncan's suggestion to form a Meat Industry Board to be established to foster the meat industry of the Colony and devise means whereby this important phase of the Colony's activities might be improved, something on the same lines as the New South Wales Metropolitan Meat Industry Board. This Board had their own slaughter-yards and refrigerators and the whole of the meat business of the metropolitan area of New South Wales was handled by the Board. He said that the cost of this large establishment was borne practically by the profits of by-products; there was no waste in the slaughter of beasts. In connection with Mr. Bayly's reference to the statement that export cattle should be produced on river-flats he said the idea was to bring export cattle to as early maturity as possible and not to prejudice the production of range-country cattle. He remarked that even among the range-country cattle the best could be used for export and the others for local consumption. With regard to stock routes, he considered that if the Meat Industry Board were

appointed this was a question that could be considered by them and there was no reason why stock routes should not be immediately proclaimed. It would be necessary for owners of plantations on stock routes to fence them. He said that he would emphasise the fact that the development of the industry depended on a market in addition to the local market and perhaps the canning of meat would be a solution. The Colony might be able to do more in this connection on account of the greater ease with which the product could be carried than carcasses. Referring to the question of branding he considered that the ear-mark was useless as a means of identification of stock. The ear-mark was liable to mutilation, liable to be absolutely cut off. About 80 per cent. of the cattle owners of Fiji used the same ear-mark.

Mr. Bayly said that before the discussion terminated he would like to add a few remarks about the ear-marking of cattle. He considered that the solution of the problem was for the Government to make it necessary for a person to have a proper ear-marking machine. At present the trouble appeared to be through the ear-mark being made with a knife.

Mr. Duncan moved the following resolution:—

That a body should be appointed by the Government to investigate fully the cattle industry of the Colony with a view to examining its present condition of over-production and future possible expansion relative to the establishment of a profitable export trade associated with similar utilization of other animal and vegetable products.

Seconded by Major Willoughby Tottenham.

Resolution carried.

Mr. Surridge read his paper "The Production and Marketing of Supplementary Crops" as follows:—

Fiji in the past has been accustomed to think only in terms of sugar and copra. More recently bananas attained importance until the embargo was placed on them by Australia. More recently still the dairying and pineapple industries have come into being and are now passing through the difficulties that beset the establishment of new industries. There is, however, one factor which is common to these branches of agriculture and that is that each has "all its eggs in one basket" so that when depression comes there is a hurried look around for other sources of income. Probably the greatest risk incurred in agriculture is that of specialising in one particular branch and to avoid this the question of supplementary crops requires consideration.

Agriculture is probably the most uncertain of all industries owing to the fact that the prime factor on which it depends is largely, at present, beyond the control of man. I refer to the weather. In colder climates this handicap has been tackled with energy in certain branches of the industry, mainly in that of horticulture, with remarkable results.

We have not the same handicap as regards temperature, but our difficulties are climatic, which while favourable to the production of many crops in season and out of season as far as our immediate markets are concerned, handicaps the producer by sapping his energy and initiative to an extent not generally appreciated. It is this latter factor that operates severely in the production and marketing of supplementary crops, for these crops demand of the producer a higher order of energy and initiative than is the case with many of the so-called major crops. Major crops generally may be classed as those required for man's necessity, while many of the supplementary crops may be classified as luxuries, and for successful treatment demand of the farmer the same intensity of treatment that is accorded them in colder

climates, for many of these crops are only in demand through man's business acumen, industry and propaganda. Further, where those supplementary crops have received earnest attention, the returns per acre from such crops are often phenomenal. It is not unusual for gross returns to reach £200 per acre, and under certain systems of market gardening, the gross returns are considerably higher. To achieve this three things are essential—(1) personal organising ability, (2) the ability for real hard work, and (3) the production of crops *out of season*.

The first two essentials are qualifications necessary for all successful enterprises and none more so than when intensive agriculture forms the outlet for such abilities. The third is the basis on which the first two can achieve success.

Fiji is so situated that the climate enables us to produce certain of these supplementary crops "out of season" for the markets that are nearest and of greatest interest to us, viz., New Zealand, Australia and Canada. I will instance one or two cases from England, illustrating the advantage of being able to produce certain crops out of season:—(1) Tomatoes there realise 3s. to 4s. per lb when put on the market one to two months ahead of the normal season, when this fruit is retailed at 4d. to 6d. per lb; (2) strawberries produced during winter have realised £1 per lb avoidupois; the normal season price would be from 4d. to 8d. per lb; (3) grapes during the winter and early spring will fetch 10s. to 15s. per lb; during the season they have been retailed at 1s. per lb; (4) pineapples from an English hothouse will fetch 10s. to 15s. per fruit. Imported fruit has been retailed as low as 6d. each.

These differences emphasise the value of supplying produce when it is out of its normal season, on various markets, and the extra cost involved is more than compensated by the higher price obtained. With these examples in mind and the fact that the climate here is generally favourable for the production of fruits and vegetables at those times when they are out of season elsewhere there would appear to be ample scope for us to concentrate more thoroughly and effectively on certain supplementary crops to our advantage. The crops that occur to me are tomatoes, cucumbers, melons, pumpkins, French beans, egg-fruit, kumalas, pineapples and bananas.

Before passing on to a discussion of the various crops there are certain factors concerning production that should be considered.

Climate.—I have already stated that we have the climate to produce certain crops at times of greatest scarcity in other countries, but it is necessary to differentiate between these crops. Some of them are tropical, some sub-tropical, while others are on the border line of sub-tropical and temperate climate crops. For this reason discretion is necessary in the methods and locations adapted for the production of the crops in question. Tomatoes, for example, do not give maximum yields at temperatures exceeding 80 degrees F., the optimum lying between 60 degrees and 75 degrees. Again, while requiring the maximum of sunlight in a temperate zone, tropical sunlight is probably too strong and therefore detrimental. Much work requires to be done to discover the optimum conditions for those introduced crops which we, by long association in more temperate climes, assume should do just as well here.

Tools.—If we examine the tools in general use on a plantation it will be noted that progress has been made with reference to horse or tractor implements, but hand implements remain the same as when indentured labour was first introduced. The cane knife is a very light and useful tool, but the

square hoe is a very heavy and cumbersome implement and one which, in my opinion requires the maximum of effort while achieving the minimum result.

The object of hoeing is to destroy the weeds and move the soil, thereby producing a fine tilth and mulch one inch to two inches in depth. To secure this desired result a horse hoe should first be worked between the lines and then followed with a light hoe, for example, the swan-necked draw hoe type which properly used will achieve the object of hoeing to greater advantage in that it is easier and lighter to manipulate and therefore not so hard on the labour, enable the work to be done more efficiently and more expeditiously, and allows of a closer working around the plants at all stages of their development. I have discussed the hoe at some length because it is perhaps the most important and useful implement in the successful production of supplementary crops.

Too much emphasis cannot be laid on the necessity of getting in amongst the crops with this implement as early as possible; that is, as soon as the plant is big enough to be distinctly seen, or in the case of transplanted ones, as soon as it is observed that the plants have taken hold and are becoming established. Attention to this detail ensures stronger and healthier plants with a resultant increase in returns.

Sowing.—This is controlled by market requirements and the object is not only to sow for the earliest market but to sow in succession to ensure a regular supply right through the season. Apart from quality of produce nothing tends to stimulate and maintain a demand for that produce as the regular supply of a good standard article. The first sowing therefore will be made at a time sufficiently in advance to ensure that the plants will commence bearing when required. Sowings in succession about every three weeks will maintain the supply and avoid failure.

Objects of production.—Obviously when producing a crop it is essential to know the purpose for which it is required. With those crops under discussion the main purpose is for human consumption, as fresh fruit or vegetables, but other objects should be considered. It is expected that our nearest markets will continue to absorb the produce we supply, but we have had one experience of a market being deliberately closed to our produce and such might occur again. Hence the necessity for preparing for such an event and thus making the production of supplementary crops a permanent industry. England is pointing out to us methods to be pursued, for having suffered year after year with gluts of fruits of various kinds, and also importing huge quantities of such produce, the question of food preservation by canning, &c., is now being tackled with remarkable success. In our case, the question of the disposal of our produce by canning, sundrying or for juice extraction should be seriously considered for it would enable our produce to be sent wherever there is a market, at all times of the year, thus extending our sphere of influence and increasing our prosperity. This is being done with pineapples and can be done with other crops. Further, we have already a small trade in seeds, I refer principally to Mauritius Bean, but it is possible and the matter is now being investigated, that certain other crops may be grown not only for the table but for seed purposes also. In this way waste would be eliminated and the producer would have an extended market and a more uniform return for his labour.

Rotations.—One of the greatest difficulties met with in intensive cultivation is the continuous supply of manures other than artificial manures. With the increase of motor traction, stable manure is almost unobtainable in some countries, and here in the tropics what little is obtainable is rapidly

exhausted in the soil owing to the high soil temperature which facilitates decomposition. There is, however, a method by which this lack of suitable manure may be largely obviated, that is by the practice known as "crop rotation."

The food requirements of each crop vary, as also do the root habits of those crops; some travel deeply, others are surface rooting, while some again leave the land richer and in a more friable condition, as is the case with most leguminous crops. If the same crop is grown continuously on the same land it is obvious that pests will have a continuous supply of food, and control of pests and diseases will be rendered more difficult.

In working out a system of crop rotation those facts should be borne in mind and the utmost use made of any leguminous crops grown either for export or for their green manurial value as a means of supplying plant food deficiencies, humus to the soil and changing the crops to be grown. Plants of the same natural order should not be grown in the same soil since they usually offer themselves as alternative hosts to the pests and diseases of the previous crop. By careful rotation, then, the soil is not so readily exhausted and pests and diseases are not given the same opportunity to produce themselves at the grower's expense. The longer the rotation, that is the greater the interval of time that elapses before a crop occupies the same land a second time, the greater the benefit to that crop whether for food supply or from the point of view of plant sanitation.

It does not come within the scope of this paper to discuss pigs and poultry, but I suggest these animals for inclusion in a crop rotation. Experience in England, America and elsewhere has demonstrated that this is both practical and valuable. Both animals are bad gardeners when allowed to roam amongst crops but if suitable pens are made that are strong and portable and high enough to contain either the pigs and/or poultry they can be moved on to the land as soon as a crop is finished, to clean up the residue of that crop, destroy the weeds and insect pests, and add valuable manure to that land, as well as giving meat and eggs in exchange for the waste materials supplied.

Crops.—The following are brief cultural details of the crops under consideration, together with a produce list that will indicate the export season for the various crops.

Tomatoes (Lycopersicum esculentum).—Require a good rich well drained loam. Seed should be sown in light rich soil some 3—4 months ahead of when required to fruit. I would suggest that all seed beds be thoroughly watered with a solution of the Cheshunt compound, as a preventative to the "damping off" and other soil fungi that attack the young plants. Transplanting should be done when the seedlings are 4-in. to 6-in. high and at the time of transplanting each planting hole should receive at least one pint of the above solution, the same amount being given after the transplanting. The Cheshunt compound is not a panacea for all soil ills of the tomato but it is of great assistance in the prevention of soil fungous disease and usually repays for application by avoiding the necessity for replanting. Further, the solution stimulates the young plant and tends to prevent the check occasioned by transplanting. When the seedlings have become established they should be carefully hoed and should receive frequent hoeings as long as it is possible to work amongst the plants. When the plants are in flower pollination may be assisted by lightly shaking or jarring the plants, usually at mid-day. Plants may be set at distances varying from 18-inches to 36-inches depending on soil, variety and method of staking, for plants usually do better staked than trailing as a vine. Water should

be given as required to maintain steady growth until the blossom buds appear. During flowering the plants should be kept on the dry side until the first truss has set when liquid manure should be supplied with or without a surface mulching of decayed manure, leaves, &c. As growth proceeds all side shoots should be pinched out until the fourth truss has set when a strong leader, the second shoot below the point of stopping, should be allowed to start out to continue the crop.

A good artificial manure to be applied when preparing the land is:—

Superphosphate 5 cwt per acre.

Sulphate of Potash 2 cwt. per acre.

Sulphate of Iron $\frac{1}{2}$ cwt. per acre.

When fruiting, some advise applying nitrate of soda or sulphate of ammonia at the rate of 2 cwt per acre, but others maintain that a nitrogenous manure depresses the yield. It is recognised that the tomato responds to potash and phosphates, but nitrogen should be applied with discretion.

Disease.—Those diseases met with here are usually soil fungi which, in the present state of our knowledge are beyond definite methods of control.

Soil sterilisation on a large scale is not a practical proposition in Fiji; therefore the best means of defence is to use as far as possible resistant varieties, *e.g.*, Marglobe, Norton, to destroy infected material by burning and to rotate the crops as already suggested. Attention to plant hygiene and more knowledge as to methods or locations for cultivating this crop offer fields of investigation which will be dealt with as early as possible at the Government Experimental Farm.

Cutworms are often a serious pest to young plants. The method of control is the use of arsenical sprays or arsenical baits. The better way would be, in my opinion, to introduce poultry into the rotation.

Cucumbers (Cucumis sativus).—This crop will stand a rather higher temperature than tomatoes provided plenty of moisture is available. The soil required consists of two parts good rich loam to one of well rotted manure with a liberal admixture of sand to keep the whole open and porous. If a compost of this mixture is made up, then planting holes 18-inches diameter and 12-inches deep may be dug and filled with the mixture ready for the seed when planting out. The large amount of humus in this compost will keep the soil moist.

Liquid manure should be given freely when the plants have reached the limit of space allowed them, and while fruiting. Each fruiting stem should be pinched at the second leaf beyond the fruit; continuous and judicious stopping is necessary throughout growth. When practicable, pollination should be carried out since this ensures a more certain crop and is easily done, both male and female flowers being on the same plant.

The three essential points with cucumbers are:—

1. a rich friable compost;
2. frequent applications of liquid manure and water;
3. continuous and judicious stopping throughout growth, and finally, one that needs investigation, protection from excessive light.

Melons (Cucumis melo).—Require a firmer soil than cucumbers, more light, and less water, and therefore a drier atmosphere.

The best soil is that obtained from well rotted turves from grass land; this mixed in the proportion of 2 of soil to 1 of well decayed manure plus basic slag (2 lb) superphosphate (1 lb) to each load of the compost forms a suitable mixture. Cow dung is excellent for the purpose.

Sowing should be 2 to 3 months prior to fruiting the plants being 1-foot to 2-feet apart, and when from 15-inches and over in length should be top dressed with the compost and the points pinched out to encourage fruiting. The laterals should be treated in the same way by pinching at not less than 1 joint above the fruit; this will avoid overcrowding. When watering, the stems must be kept dry, otherwise they are liable to rot. As with cucumbers pollination should be carried out. It is recommended that plants be restricted from 5 to 8 fruits according to the vigour of the plant and size of fruit desired. Judicious watering with liquid manure during fruiting will add to the size and quality of the crop.

Pumpkins (Cucurbita maxima).—Soil requirements are similar to those of the cucumber and melon in that a good rich soil is required. Seeds may be sown in holes previously prepared in a way similar to that required by the cucumber, some three months or so before the fruit is required, the vines being allowed to run over the ground without supports. Liberal waterings either of water or liquid manure should be given as required.

French beans (Phaseolus vulgaris).—This is a crop that has not received the attention which it appears to deserve, for export purposes. There is a limited market in Auckland from May to October, capable of absorbing according to present information about 1 ton of these beans a month. One consignment of French Dwarf and Canadian Wonder—some 35 lb in weight—was despatched recently to New Zealand where they realised 9½d. per lb, equivalent to 4-3d. per lb on the wharf at Suva. As this shipment occurred near the end of the season it is reasonable to suppose that prices should be more advantageous earlier in the year. Even so the return is higher than is obtained in the local market.

Deeply worked soil is essential together with a dressing of lime (1 ton) or coral sand (5 tons) superphosphate (4 cwt.) and sulphate of potash (1 cwt.) per acre. If compost or well rotted manure is available it should be sown in the furrow over which the beans will be planted.

Seed should be sown in treble rows, at about 9-inches apart in rows that are 2-feet apart centre to centre. Sow at intervals of three weeks throughout the season. When the flowers have set and the pods are forming applications of water and liquid manure would be beneficial to ensure rapid and succulent growth as beans for overseas must be tender to secure a fair price.

It is possible, however, that a certain proportion of the crop will be too old for shipment, or local prices too low to give a satisfactory return. This difficulty is at present being investigated along the following lines. At the Government Experimental Farm at Navuso a proportion of the crop was allowed to run on for seed. Samples of this seed are being despatched to Auckland and Sydney for examination and report, and if its germination and bearing qualities have not been impaired by production in the tropics and if reasonable prices are offered for sound clean seed of certified germination and purity, the growing of French beans for export, both for table and seed purposes, should be profitable.

Egg Fruit or Bringals (Solanum melongana).—Cultivation is very similar to that of the tomato. Seed should be sown in boxes containing light rich soil and the seedlings transplanted when about 3-inches high into rows 3-feet by 2-feet. The hoe should be used freely as in the case of the tomato to maintain a good soil mulch. If possible a mulching of rotted manure and leaves should be given. Plants yield an average of 12 marketable fruits a season.

Varieties:—The purple is favoured in our markets, but the white might be worth while trying although stated to be of not such good flavour.

Kumalas (Ipomœa Batatas).—The sweet potato is familiar to us all and forms a useful export crop apart from that required for local consumption. A good moderate friable soil is required which should be well and deeply cultivated, and ridged, the ridges being about 2½-feet apart. Cuttings should be planted in the ridges at about 12-inches to 18-inches apart. Better results are obtained from cuttings than from tubers and it is a good plan to plant tubers in nursery beds and then cut off the stems when a foot long and plant these. Planting should be done for preference during rainy weather, and when the plants have rooted they should be hoed, care being taken not to damage the foliage. At the second weeding a final earthing up should be given. The crop matures in about 4 months and returns about 4 tons to the acre. Crop rotation should be practised. This crop greatly benefits the land by the continuous cultivation given up to and during the harvest. The leaves are excellent fodder.

Varieties:—The white preferred in the Canadian market. The red and pink preferred in the New Zealand market.

Pineapples (Ananas sativus).—At present we are concentrating on the canning pine—the smooth leaf Cayenne and no attention is paid to producing a good quality dessert pine either for local or export trade. The “Ripley” pine is probably the best, being very sweet and a good traveller, but stocks have deteriorated and the matter is receiving attention by the Department both as to stocks, quality of fruit and methods of marketing, to discover the possibilities of this branch of the trade. If Queensland can export pineapples at a profit to New Zealand, there is no reason why we should not do at least as well. We should do better.

Bananas (Musa sapientum).—This crop is receiving considerable attention at present but the methods of packing, transport and marketing of this soft fruit need careful investigation so that our market may be extended beyond New Zealand.

There are other crops that will occur to you, but in all cases the fundamental principle behind successful crop production is care and attention at all stages from the sowing of a crop until it has been placed on the market.

Marketing.—If crop production is a science the marketing of the crop is not less a science, demanding just as much energy and concentration of effort to secure a successful result. The producer should so handle his crop that by putting good quality produce on the market in as attractive a manner as possible the consumer will be induced to buy at all times.

Handling of Produce.—With all perishable produce the greatest care is necessary and should be enforced at all stages between the plantation and the steamer at Suva.

Bananas are rough handled from the time they are cut off the tree until they are packed into the case and sometimes after. Unfortunately much of the damage is not apparent until after the fruit has left Fiji. In view of the increasing competition from Samoa and Cook Islands, it becomes increasingly important that the utmost care should be exercised. The difficulty is that of educating those people immediately concerned.

With tomatoes the fruit should be gathered and either automatically graded and packed directly into the case or else taken to a cool packing shed on the plantation to be packed for markets. The present system which involves collection from the plant into any available receptacle, carting to a central packing station, when the fruit is dumped on the floor in heaps 2-feet or more deep and perhaps left overnight before being packed does not tend to improve such a soft fruit. The present method of grading

involves selection from the heap so that the fruit is handled many times to secure the correct sizes. It is hoped shortly to improve the system.

One can appreciate the amount of bruising possible under such conditions. After packing, the fruit is carried in lorries to Suva, the vibration by no means improving it; the voyage from Suva to the markets occupies several days.

Such a system is wasteful of time, fruit and energy. It is typical of the treatment accorded to most produce exported from Fiji and represents how *not* to do things. I would repeat that to ensure produce travelling well and arriving in sound condition on the market, the greatest care and attention should be given at all times.

Packing.—All are familiar with the attractive packages in which various commodities are received from overseas for sale in this Colony, and without exception both the sales and prices obtained represent a reasonable profit to the producer or manufacturer. These attractive packages are the result of sound business acumen and keen competition. The most familiar goods with us are the Australian fruits in cases or cans, Californian fruits in cartons, cans, &c., and confectionery. In each case the producer and manufacturer has realised that he has something worth selling and has induced the consumer to appreciate the fact by the type of package in which the goods are marketed. Contrast this with the cases which leave Fiji filled with bananas, oranges, tomatoes. If the timber for these cases was dressed a marked improvement in appearance would immediately be observed with negligible additional cost. Where paper wrapping is allowed, further improvement in appearance can be effected by lining the box or wrapping the fruit in white or coloured paper.

Finally, an important point in packing is overlooked in this Colony. Certain classes of produce allow for definite methods of packing and since in many cases the first or bottom layer in the pack is more uniform and attractive than the last, the mark or brand should be placed upside down so that when the case is filled the lid will automatically be made the bottom of the case. In this way the mark indicates "right side up" and the best layer receives due prominence.

Grading.—Having secured improvements in handling of the produce and the containers used, the next step is to grade the produce. Many consider grading unnecessary, but it will be found that the keener the competition the greater the necessity for grading in order to market a standard product. A case of fruit of good quality, well graded and packed and marked accordingly will always command and maintain a higher price even in times of glut.

The merchants in Fiji who import apples, &c., buy those apples on the brand, never seeing the fruit until after arrival in the Colony. Such brands by careful attention to the points already enumerated in this paper have obtained such a reputation for quality, &c., that confidence is inspired in customers hundreds of miles away.

In many branches of agriculture and industry grading has been introduced by legislation owing to the stress of competition, with the result that ungraded produce has no sale outside the local market.

Standard or National Mark.—Many successful business organisations can trace their success not only to the quality of goods produced but to the adoption of a "Trade Mark." To-day many countries have adopted a national mark as an indication not only of the country of origin but also as a recognised standard of quality. This adoption of a standard or national mark represents one of the best and cheapest advertisements for assisting good quality produce on the market.

Fiji is without such a mark at the present time, but that registered for use by the Department of Agriculture, viz., the Fijian's head over the word Fiji, is one that is distinctive and attractive, and through the efforts of the Department is becoming recognised as a standard of good quality produce. This mark should form the basis of a national mark for produce of recognised quality and packing exported from the country. I commend this to your serious consideration.

Fruit Preserving and Fruit Juices.—The preserving of fresh fruit by canning is already practised in Fiji with reference to the pineapple but I look forward to the time when our canneries will not restrict themselves to one crop but extend their operations to include tomatoes, fruit juices and other products. With our climate and soil many varieties of fruits and vegetables can be successfully grown but as this branch of agriculture extends, means to market surplus crops will have to be considered so that our export markets may be extended beyond New Zealand and Australia. Many fruits and vegetables can be canned or sundried or both, others are suitable for essential oils or juice extraction. Recently a process has been invented and patented in England by which fruit and vegetable juices may be extracted and preserved indefinitely without the addition of harmful preservatives. The process, called the "Matzka treatment" involves the destruction of organisms producing fermentation, putrefaction and disease present or likely to be present in the freshly extracted juice. Such a process would tend still further to eliminate waste and extend the possible markets open to the producers.

Co-operation.—Co-operation has been preached in many places for many years with varying success. One of the first of the agricultural countries to adopt and extend the idea was Denmark, when some seventy years ago, the agricultural industry put its house in order and established the co-operative movement throughout the land. The result has been that the Danish producers are a very prosperous community and one of the most serious competitors that the Empire dairying industry has to face.

The fruit growers of California have, in more recent years, demonstrated the value of "getting together" by the way in which their fruits, &c., are spread in many markets. In Great Britain, several agricultural communities appreciating the benefits of "getting together" to purchase and to sell produce, have formed their co-operative societies with advantage to themselves.

In Fiji co-operation is familiar to the native, but not to the other residents in the Colony. During my peripatetic work I have discussed the advantages of co-operation amongst copra and other producers. Interest has been aroused only to subside apparently for the lack of will to pull together.

Co-operation is not a panacea for all marketing troubles, but a band of producers combined together can more successfully enforce the benefits of packing grading and marketing of produce than the individual. Machinery for grading and packing could be obtained by such a body and transport, canneries and shipping facilities improved.

Time does not permit of a full discussion of this point, but it is offered for the serious consideration of all concerned.

Propaganda.—Before concluding this paper, I would draw attention to the old axiom, "it pays to advertise." Some fifty years ago, the banana was considered a luxury fruit on the English market. It is now a popular fruit on which an enormous trade rests. This has been brought about by propaganda, in which the health and dietetic value has been broad-

casted under such slogans as "Eat more bananas," "Bananas are recommended by the medical profession." The success of this and other industries has been largely due to suitable and vigorous propaganda carried out by the particular branches of industry concerned.

Fiji cannot afford to hang back, provided she has the quality goods to offer, and if co-operation amongst producers can be brought about, propaganda dealing with their various products should be conducted so that the produce is known outside of Fiji.

In conclusion I would suggest that co-operation grading, packing and efficient propaganda constitute very important essentials in the successful marketing of perishable and other produce.

Appended is a "Produce for Export" list indicating the seasons most profitable for export, and the markets concerned.

PRODUCE FOR EXPORT.

<i>Crop.</i>	<i>Season.</i>	<i>Destination.</i>
Bananas	January-December	.. Auckland.
Beans—French ..	August-October	.. Auckland.
Mauritius ..	July-November	.. Sydney, Brisbane.
Bell Apple	June .. ..	.. Sydney.
Coconuts (whole) ..	January-December	.. Vancouver.
Cucumbers	May-October ..	.. Auckland.
Egg Fruit	June-December	.. Auckland
Ginger	March-October ..	.. Sydney, Vancouver, Auckland.
Grenadillas	January-December	.. Auckland.
Kumalas	June-November	.. Sydney, Vancouver Auckland (August),
Mandarins	March-June .. ..	.. Auckland.
Melons	September-February	.. Sydney, Auckland.
Oranges	March-June .. ..	.. Auckland.
Papaya	September-December	.. Auckland.
Peanuts	March-June .. ..	.. San Francisco (March), Auckland (June).
Pines	October-January	.. Auckland, Vancouver.
Pumpkins	September-February	.. Sydney.
Tomatoes	August-December	.. Sydney (August-October). Auckland (October-December)

Major Joske said that it was a great pleasure to listen to such a full and interesting paper as the one read by *Mr. Surridge*. He did not think that *Mr. Surridge* intended to convey the idea that any European could make a living out of pumpkins, tomatoes, &c. He suggested that the co-operation of the Chinese Consul, the Secretary for Indian Affairs and the Secretary for Native Affairs should be sought in connection with this subject as the large proportion of pumpkins, tomatoes, melons, &c., were exported by Chinese, Indians and Fijians, and it was to them that we had to look for the production of these crops in the future. He remarked that one of the leading Fijian Chiefs had said to him "Why don't we have a Fijian Agricultural Conference?" Why also were not Indian and Chinese Agricultural Conferences held? The Conference had heard a good deal about the future development of the banana industry in Fiji; in relation to supplementary crops we had products which were solely in the hands of Fijian, Indian and Chinese population so that again he expressed the need for the Department of Agriculture to extend their advice, their sympathy and their help to the Indian, Fijian and Chinese growers. He said that as far as bananas were

concerned we should be able to meet the competition from Tonga and Samoa and if we could not then Fiji deserved to lose the trade. He said that Mr. Surridge had mentioned in his paper that £200 per acre per annum could be made from the cultivation of certain crops. He wished that it was possible to convince some of the present settlers in Australia and New Zealand of these figures. He knew of many thousands of acres of land which were available in Fiji at a nominal rental of £1 per acre per annum. Major Joske remarked that tomatoes were a very useful crop which was grown almost entirely by Chinese, and these had been bringing into the Colony something like 8s. or 9s. per case, which was a point well worth considering by our Asiatic population. The co-operation of the Chinese Consul should be sought in translating the very excellent cultural notes of Mr. Surridge's paper for circulation.

With regard to the question of grading, Major Joske intimated that if grading of bananas was undertaken then the system of purchase would have to be altered. At the present time bananas were bought by the case and it was possible that a loss would be sustained by grading the fruit in Suva. If the system were altered and purchases were made by weight, payment being made at so much per pound, this would get over the difficulty. In Fiji bananas were grown in very scattered districts and not in plantations as they are in Australia.

Touching on the question of co-operation he said that this was a very difficult thing even among Europeans of the Colony and he thought that it would be extremely difficult to devise a workable scheme amongst the Fijians, Indians and Chinese. As an example of co-operation he referred to the Coconut Planters' Union Limited which comprised members of the copra producers. This Union had been running for something like ten years; it was concerned solely with the collecting and shipping and selling of copra and had been successful for two reasons; firstly, because it had dispensed entirely with trading, and, secondly, that it had dispensed entirely with ordinary politics. These two factors he said had been the cause of the wreck of most Co-operative Societies in the Colony. In normal years the Union distributed amongst its members somewhere between £25,000 and £100,000.

With reference to propaganda he thought that this was an excellent thing and could be easily managed as far as the European producers were concerned, but with regard to Chinese, Indian and Fijian producers he considered that it would be very difficult to convince them of the advantage of advertising in Auckland and elsewhere. He remarked that on a recent visit to Auckland he had been accused of advertising over the air. He considered that there was a very definite necessity for advertising and he thought a small export levy might be made on the export of bananas for instance, the sum realised to be spent on the advertising of Fiji fruit in New Zealand. He would not suggest a small insert in the daily papers, but considered that the scheme should be put in the hands of an Advertising Agency and a day or so before the "Tofua" arrived in Auckland signs depicting Fiji and Fijian bananas should be shown in the picture theatres. He remarked that those who had visited the Agricultural Show would doubtless have seen the very fine posters which had been prepared advertising Fiji and he considered that there was excellent local talent available which should be utilised.

There was one other small point that he would like to direct the attention of Mr. Surridge to and that was kumalas. Mr. Surridge had shown the season for kumalas as from June to November, the Auckland season commencing in August. His experience had been that the season was now over for all practical purposes. The season had been a good one for kumala

as far as Fiji was concerned because the local crop in New Zealand had been a failure and the cold weather had lasted longer in New Zealand than normally. The Maori was the principal consumer of kumalas, but they did not eat so many in the hot weather as they did in the cold. He informed the Conference that when the returns of the last shipment were received it would be found that the price had dropped considerably. In connection with the development of pure line seed, he remarked that Mauritius beans had been grown for many years in Fiji and should be encouraged, but unless something was being done to improve the seed he considered that the quality would deteriorate. He would like to see the Agricultural Department, if it was not already doing so, develop suitable strains of Mauritius beans which would be suitable for use in this Colony. Some results had been obtained with the growing of Sonacalif rice seed and although it was rather early to come to a definite conclusion in this respect there was every indication that this would improve the quality of rice produced in the Colony.

The Chairman suggested that the paper on the Pineapple Industry should be now read and discussed in connection with Mr. Surridge's paper.

Mr. Barnes read Mr. G. Garrick's paper "Pineapple Growing for Canning" as follows:—

Selection of land.—Pineapple growing in Fiji has been carried on sufficiently long to prove that certain theories, accepted and established in Hawaii, do not apply here where selection of land is concerned. Pineapples will grow and produce equally well at sea level as they will at 500 feet above sea level. Suitable land may be described as low undulating hills which can be worked by machinery. Steeper country is equally good, but expensive to work. Experiments being carried out on river flats are not yet complete and until completed it is suggested that such land be avoided for pineapple cultivation. Fruit produced on river flats may appear perfect, but if the soil contains too much moisture then, as likely as not, the core of the fruit will be found to be a brownish colour and such fruit will be rejected by the factory as being unfit for canning. Provided pineapples are cultivated on hill sides and drainage is good, a heavy rainfall is not an adverse factor.

Nature of soil.—The soil on the Island of Ovalau has been and is producing a pineapple which when canned has been pronounced by experts to be equal to if not actually superior to, the highest grade of canned pineapple for sale on the world's markets. The soil of Ovalau where extensive cultivation of pineapples is being carried on, is of reddish brown colour. When dry it is very loose and friable, and after rain drains itself very quickly. The iron content is good and in a form easily and readily absorbed by plant life; this feature is essential to successful cultivation of pineapples. The localities referred to are Wai-ni-Loka, Bureta, Waidau, and Viro. Experiments carried out on river flats at Waidau should be sufficiently finalised by December, 1932, to decide the suitability or otherwise of this class of land for pineapple cultivation.

Drainage.—Proved suitable land will drain itself, *i.e.*, hill land. It is sometimes necessary to instal a system of drains to prevent erosion. No hard and fast rule in this respect can be laid down and the particular nature of the country must decide the system to be adopted. The general principle is to select a natural valley or water-way and into this lead feeder drains cut so as to permit the water to flow slowly. The thing to be avoided is a sheet of water coming down a hill-side carrying tons of soil with it.

Preparation of soil.—Hill-sides with an angle of slope not exceeding 25 degrees may be ploughed. From 25 to 45 degrees should not be deeply cultivated owing to subsequent rapid erosion from heavy drains. The pineapple plant has a small root system, which does not need deep tilling as has been proved from experience. If the land is as described under the title of "nature of soil," then all the "cultivation" necessary can be done with a mattock, and a strong arm. Dig a hole some 8 inches in diameter and 5 inches in depth and loosen the soil so dug and replace in the cavity it was dug from. This method is cheap and will produce excellent results. It is time enough to use the plough when exhausted ratoons have to be ploughed out.

Selection of plants.—Plant material may consist of (a) ratoon suckers which come from the ground level, (b) suckers or sprouts which come from the parent plant above ground level and (c) slips which come from immediately under the base of the fruit. The suckers and sprouts are much more plentiful than slips, so for practical purposes let us keep to the first two. These should be selected from strong and vigorous plants and detached when from 8 inches to 12 inches in growth. When detaching wear a strong leather glove and insert the thumb well down between the parent plant and sucker or sprout to ensure making the break right at the parent plant. Crowns should be selected for their smallness. Large crowns should be avoided as these indicate a large core. Crowns are cut from the fruit, not broken off.

Treatment of plants prior to planting and planting.—All plant material should be exposed to a strong sun, root end up, for at least seven days. These are then peeled, *i.e.*, about six or eight of the small leaves removed and the stalk cut square off. They are then ready for planting. Two rows planting 18 inches by 18 inches with 4 inches spacing gives about 8,600 to the acre; three row planting 12,400 and four row 13,600 to the acre. The mass planting gives an increased tonnage with a decreased diameter of the fruit, which is desired by the factory. A great deal could be written on the subject, but for practical purposes the above should be sufficient to meet all preliminaries.

Weeding.—Pineapples should be kept fairly clean of weeds, and by hand this will cost anything from 17s. 6d. to 25s. per acre for each weeding. The rainfall usually regulates the number of weedings necessary and that all important factor known as experience.

Harvesting.—Again experience only can teach when to harvest. This fact, however, must be remembered: the pineapple stores its starch in the stem which attaches it to the plant, and it is not until the fruit commences to ripen that the starch is converted into sugar and absorbed by the fruit. Therefore, if a green or partly ripe fruit is removed from the stem, the process of sweetening is at once arrested. If planters supply or attempt to supply unripe fruit to the factory they will be met with a withering blast from the canner, because he has to add cane sugar to make up the deficiency of fruit sugar.

Transport.—Handle ripe pines as you would a basket of thin shelled eggs. Bruised fruit is "unfit for canning" and in that expression are a mountain of argument, hard words and strife and a smaller cheque than anticipated.

In conclusion the only fruit which is "fit for canning" is the lucious pineapple known as the "Smooth Cayenne."

Mr. Riaz.—In the absence of Mr. Godfrey Garrick it has devolved upon me to speak on the important subject of the Pineapple Growing and Canning Industry in Fiji.

It appears to me that there are three heads under which the pineapple business should be dealt with—growing, manufacture, advertising and marketing.

That Fiji can grow a pineapple suited in every way for canning is an established fact. This being so we have only to decide on what is the type of soil most suited to the requirements of the plants, and what method of cultivation should be adopted. Generally speaking, the pineapple in common with all other cultivated crops requires that the soil be deeply and thoroughly ploughed and brought down to a fine tilth before the plants are put in. The pineapple plant, contrary to the belief widely held, has a deep rooting system. I myself have traced the roots to a depth of 2 feet. 6 inches. Intermediate cultivation should be carried out by pony-plough and scarifier until the plants are out of hand. Colour of the soil does not seem to give much indication of its fertility for pineapple growing, though it is as well to avoid planting on heavy black soils as indicating a high manganese content. This constituent in the soil is detrimental to the health of the plant.

Soils that carry a high oxide of iron content grow the healthiest plants and produce the soundest fruit. The plants like a fairly high acid soil, but good drainage and dry feet are absolutely necessary. Sloping land is the most suitable, with small catchment drains dug around the tops of cultivations, and a system of contour planting should be carried out, *i.e.*, the rows should be across the slope of the land and *not* up and down the hill sides.

Preparation of plant material.—The experience on Votualevu, Nadi, is that just as good, or maybe slightly better results are obtained if the suckers are put in directly they are detached from the mother plants without sun-drying or stripping off any of the leaves. Only one of our growers strips the leaves off his suckers, and he does not seem to have had fewer losses from plants dying after planting than other growers. This gentleman has planted close upon 100,000 plants this year with a loss from death of 30 plants. The total number planted for the year is in the vicinity of 600,000 with a total loss of 100 plants through rot, so it would appear that on the score of cheapness it is better to avoid the expense involved in the stripping, extra handling and sun-drying of plants. We strip all plants off the main plant leaving all shoots from the ground for the bearing of the ratoon fruit.

Harvesting.—Like all other fruit the pineapple must be handled carefully when being harvested, and during transportation to the cannery. The fruit should be left on the stalk until the colour is showing yellow for about half way up the fruit. If these points are observed the fruit may be kept for as long as 10 days without deterioration. Bruised fruit ferments rapidly, and is therefore not suitable for canning if it has been harvested over 12 hours.

Out-put.—Within the space of 10 years from now my Company, by natural expansions from our own plant supplies, will be faced with the problem of having to handle 1,000,000 cases of canned pineapples. Then comes the most important question of cheap supplies of Empire cans, automatic pineapple-canning machinery, advertising, marketing and cheap freights.

Empire can supplies.—Up-to-date British can manufacturers have not been prepared to supply collapsed can bodies and covers, and we have therefore been forced to obtain our supplies from the American Can Company.

Can reforming machinery.—Can reforming machinery and closing machines have had to be hired from the American Can Company, which

necessitates our purchasing spares from that Company, all of which are manufactured in America, and therefore have to bear heavy duty.

Canning machinery.—In the past we have had to purchase all our canning machinery from America at high cost and after the 28th June next, just when we will be entering into our first period of expansion, we will be faced with having to import from that country large quantities of canning machinery without the benefit of a rebate of the duty levied on such machinery, because that concession expires on that date. As there does not appear to be much chance of British Manufacturers giving us this type of machinery before the 28th June, 1932, this may not be an inopportune time to suggest that the Government extend the period for a further two years, *i.e.*, to the 28th June, 1934.

Freights.—At present freights to overseas markets are too high, but doubtless when we have large shipments to despatch we will be able to obtain more advantageous rates, and so this problem will in a measure solve itself.

Marketing.—The old saying "that though a man live in the middle of a forest, if he makes a better mouse-trap than another man the public will wear a footpath to his door" is well answered by "early to bed and early to rise is not worth a cuss if you don't advertise." Whilst not saying that we in Fiji can put up a better canned pineapple than the other man, I do say that we can put up just as good—but the other chap has a long lead on us, and the only way to catch up to him is for us to continue putting up a good article, and advertise and continue to advertise. This will mean entering into an extensive advertising campaign throughout Great Britain and Canada and the Continent. Now, this will mean that we will require a large amount of money, and I doubt if the Companies operating in Fiji can finance such an undertaking, though it is vitally necessary, not only to the welfare of the Companies concerned, but to the Colony as a whole, that such a campaign should be launched with as little delay as possible. I think that I am not being optimistic in estimating the possible out-put by the two Companies at present operating in Fiji will, inside 10 years, reach 2,500,000 cases. I will not go into figures, but leave it to you gentlemen to calculate the benefit that will be derived by the Colony in revenue, not to mention the cash put into circulation by such a quantity of fruit being canned in Fiji. I may state that the Empire marketing Board has only recently assisted the Colony of Mauritius to the extent of obtaining 300,000 pineapple tops from Hawaii for the purpose of assisting the people there to establish a pineapple canning industry. This cannot entail a lesser outlay than £5,000 when all costs are taken into account. The Queensland Government have lately decided to assist the export of canned pines to the extent of £20,000. These facts embolden me to suggest that the Government interest some such body as the Empire Marketing Board in assisting to finance such a scheme, such finance to be repaid by making a special levy of a certain amount per case canned.

In conclusion Mr. Riaz mentioned the fact that the Canadian market now required Certificates under the Pure Foods Ordinance 1925 and suggested that the Government should bring this Ordinance into operation forthwith.

Mr. Ricketts said that he did not agree with some of Mr. Riaz's statements regarding the cultivation of pineapples. He pointed out the fact that at Nadi it was possible to cultivate by machinery, but that at Waidau the land was fallen bush country too steep to work with ploughs and also covered with stumps, which would probably disappear in three or four

years. For these reasons the Waidau pineapples were cultivated with mattocks and shallow cultivation by making a small hole, and this method had been found most successful. One difficulty experienced at Waidau was to get a pine small enough in weight to suit the small tins required by the trade. Pines weighing up to 9 or 10 lb were grown on Ovalau and there was too much waste. The ideal pine for canning weighed about $3\frac{1}{2}$ to $4\frac{1}{2}$ lb.

Mr. J. L. Hunt said that he must congratulate *Mr. Surridge* on the very able paper which he had put before the Conference on the matter of Supplementary Crops. He remarked that if *Mr. Surridge* could guarantee £200 per acre return per annum there would be plenty of people anxious to come to Fiji. He himself would be very glad to know what the crop was. The important thing was not to tell growers how to grow their crops but to tell them how to market their crops and what their return would be. He did not think it wise to put an additional tax on bananas at the present time. As he had said in his paper there were practically no Europeans producing bananas at the present time, but he did not see any reason why there should not be if Europeans could be assured that bananas could be produced free of disease. Disease was the big bug-bear at the present moment and Europeans did not want to plant up bananas that would only last 12—18 months. He said that conditions had improved since the floods of 1929 and 1930 and there had been a reviving interest amongst European planters. He agreed with *Major Joske* that the cultivation of kumalas, Mauritius beans, maize, &c., were more suited to the Indian, Fijian and Chinese population. The big thing was to produce the crop in Fiji when the prices were highest on the market. He said that the question of grading was a very serious one. So far as the European was concerned there was no trouble if he were the producer because it was in his interests to see that the material was properly graded. The European purchaser of native fruit had to travel over large areas in order to collect the fruit and although the quantity might only be 500 cases the number of individual owners might be anything up to 50. For this reason it would be easily understood how difficult it was to grade on the packing stations. *Mr. Hunt* remarked that another big difficulty was the fact that the producer wanted too much for his produce. If the prices were reasonable the consumption would be larger and this would compensate the grower because he would be able to dispose of a greater quantity of produce. In conclusion he urged upon the Government to demonstrate by experiments the crops which could be grown, the cost of production and the return to be expected from them.

Mr. Pearson (Secretary for Indian Affairs) said that he would like to join with *Major Joske* and *Mr. Hunt* in congratulating the Conference on having secured from *Mr. Surridge* such an admirable and illuminating paper on the subject of Supplementary Crops. He felt that the paper dealt with all aspects of production, marketing, grading, &c., and he would like to have the paper sent to the Natabua Training School and to have it translated into Hindustani for circulation amongst Indian growers. He said he was particularly interested in *Mr. Surridge's* remarks about the cultivation of grapes for the out-of-season market. He said that he knew something about the Channel Islands and he wondered if Fiji could not be the "Channel Islands" of New Zealand and Australia for out-of-season crops. Speaking on the question of rotation of crops he was inclined to the opinion that perhaps the Indian through tradition went in for too much variety. He was much interested in what had been said about tomatoes. He came from a part of England where tomatoes were grown in large quantities.

Apart from the fruit which was sent to the market there was the question of the collection of small and green tomatoes to be made into tomato chutney and he wondered if this industry could not be established in Fiji. Mr. Pearson said with regard to beans he was interested in this matter mainly from the point of view of rice growing, and he considered that the Indian farmer required some other bean crop to grow in the off season. Another point in Mr. Surridge's paper which particularly interested him was the cultivation of the egg-plant. Mr. Pearson remarked that the egg plant was a delicious thing and it seemed possible that the cultivation of this could be extended in Fiji. Speaking on the question of co-operation Mr. Pearson said that he was associated with Mr. Barnes on a Committee which had been considering ways and means of encouraging co-operation amongst Indians. They had come to the conclusion that it would be necessary to move slowly in this matter and in the first instance to encourage the Indians in the establishment of suitable crops and then gradually work in a scheme of co-operation. He remarked that the officers of the Agricultural Department were doing splendid work in assisting the Indian community to produce crops which would be of benefit to them and he thought that organisers or superintendents were needed to organise the marketing of the produce. He considered that it would be possible for these organisers to get in touch with the small producers and to go into matters connected with production and marketing. During the discussion last year on minor crops Mr. McGowan has supplied some very useful information in connection with the production and marketing of minor crops. Mr. Pearson said that he wondered if concentration on overseas markets was not too marked. He considered that one remedy for the present depression was concentration on the home market and production for home consumption. There was no doubt that the returns would show that the value of products imported into Fiji ran into a very considerable amount and there seemed to be no reason why some of these products could not be grown in Fiji and not only keep the money in the country by cheapen the price of the commodity. He mentioned one commodity, ghee, and said that lately the Indian settlers had become quite enthusiastic about the local product which was much superior to the imported article and also much cheaper.

Mr. Wastall said that he had great admiration for the work which the Agricultural Department had undertaken during the last few years. One thing he would like to mention was the maize-meal bread which the Department had distributed at the Show and he felt that there was no reason why we should not make the bread in Fiji instead of importing the wheat flour. He agreed with all Mr. Surridge had said and also wished to join with the previous speakers in congratulating Mr. Surridge on the excellent paper which he had presented. He maintained that Fiji would not progress until there were more European settlers. He emphasised the fact that there was plenty of room for anyone who went about it in the right way to do well on the land in Fiji. Turning to the question of beans he drew attention to the fact that rice bean was valuable in three ways, namely, cover crop, seed producer, and as an edible product. He understood that the Colonial Sugar Refining Company were at the present time using large quantities of rice bean as a cover crop and that it was being produced in Australia in place of the Mauritius bean. Nature produced about 7,000 orders of legumes of different varieties and he stressed particularly the advantages of the rice bean which produced prolifically; the crop could be picked every morning for three months and the bean was an excellent food for fowls as well as for man. There was another plant which he thought

was indigenous to Fiji and that was the Nasau. It was a Solanum and no effort seemed to have been made to cultivate it in Fiji. He knew that the plant grew very freely.

Mr. Barnes said that the discussion on the paper presented by *Mr. Surridge* had gone on for some considerable time and perhaps it was opportune to say a few words in order to clear up a few misapprehensions which might have arisen after the remarks of some of the speakers. He said that the object of the paper was not so much to stimulate Europeans to take up supplementary crops, but to put into a concrete form information which had been collected by the Agricultural Department, mainly by *Mr. Surridge* on the production and marketing of crops which were being grown to an increasing extent by Chinese and Indians in the Colony. He said that unfortunately the Chinese Consul found himself unable to contribute to the discussion, although he was present at the Conference, but he had expressed the keenest interest in this subject, and had promised to use his influence. Major *Joske* in the course of his remarks suggested the co-operation of the Chinese Consul and certain Departmental Heads of Governments. *Mr. Barnes* informed the Conference that at the present time there was the Agricultural Advisory Committee, which unfortunately had not the assistance of the Chinese Consul, but it included the Secretary for Indian Affairs, the Secretary for Native Affairs, also the Director of Education who could give much assistance in connection with the training of school children in agriculture. He thought that the idea of a Fijian Agricultural Conference was an excellent one. The opportunity was taken during the Annual Meeting of the Young Fijian Society to deliver an address on matters closely concerning Fijian agriculture. The Department of Agriculture had carried on work on the questions that had been suggested at previous Conferences and one object of the Conferences was to indicate the results of investigations. One of the difficulties which had been experienced was the securing of proper seed, but shortly it was hoped that the Department would be in a position to distribute a limited quantity of various seeds. Referring to the pineapple paper *Mr. Barnes* said that there appeared to be some difference of opinion, perhaps not so serious as one might think, between the people who were planting at Waidau and those planting at Nadi. It was evident that the Waidau people had been very successful in producing fruit with shallow cultivation.

Mr. Barnes read the salient points of the Paper* on the "Citrus Exports—Experimental Shipments," and said that Fiji was particularly favourably placed in regard to citrus exports because of the possibility of getting fruit of good quality on to the New Zealand market when none other was available and to Vancouver market after the New Zealand market had become weak. The system of preferences within the Empire should go still further to encourage the development of this industry. He remarked that he saw little prospect of Europeans taking any large part in the actual growing of the citrus fruits, for some time but the Agricultural Department had imported varieties of citrus and had also secured plants of varieties scattered throughout the Colony which were known to be very popular in the export market.

Mr. Barnes in rising to close the Conference said that those who had been responsible for the organising of it had been very gratified at the interest evinced in the subjects dealt with. He thought that perhaps the information which had come to light during the discussion on the Stock Industry was the most important aspect of the Conference, and points

* Published in *Agricultural Journal* No. 2 of 1931.

had arisen which would be given early attention. The present Conference had been organised on similar lines to those of the first Conference and the idea was to let the public know the results which had been achieved in the course of inquiries pursued by the Agricultural Department. He wished to make it quite clear that the Department did not seek publicity, that the object of the Conferences was not to boost the Department, but he felt that it was the duty of the Agricultural Department to take the public into its confidence from time to time and to let them know what had taken place. Speaking on the question of publicity which had been raised by at least two contributors to the discussions he thought that the question of advertising Fiji bananas and Fiji produce might well be referred to the Fiji Publicity Board. For the past 15 or 18 months he had been Chairman of that Board and the question of advertising Fiji and also its products had been very closely before the Board. He mentioned that the Board had offered a prize of £5 for the best poster advertisement of Fiji, and the poster which had won the prize had something to do with all the industries of Fiji which had been briefly touched upon, and illustrated the keen observation of the person who had designed it. Mr. Barnes said that on behalf of the organising Committee he wished to express the thanks of the Conference to His Excellency the Governor for the keen interest which he had continued to take in the Conferences and also for his presence during a number of the discussions. Thanks were also due to the Suva Municipal Council for so kindly placing the Town Hall at the disposal of the Organising Committee. He also wished to thank Mr. McHugh, the Government Printer, who had gone to considerable trouble in the preparation of papers for presentation to the Conference. In conclusion Mr. Barnes extended thanks of the Organising Committee to all those who had prepared papers for the Conference and to those who had attended the meetings and had taken part in the discussions.

Major Joske said that the thanks of the Organising Committee, consisting of Messrs. J. L. Hunt and E. Duncan and himself were due to Mr. Barnes on whose shoulders had fallen the duty of organising the Conference. He remarked that all the Organising Committee had done was to attend a meeting at Mr. Barnes' office at 2.15 p.m. one day and say, "Yes, yes, go ahead." He said that the efforts of the Agricultural Department were fully appreciated by the presence at the Conference of His Excellency the Governor. In conclusion he would move a hearty vote of thanks to Mr. Barnes and the members of his staff who had been responsible for such an interesting and instructive Conference. (Carried by acclamation).

FORESTRY IN FIJI.

By R. A. SYKES, Conservator of Forests, Fiji.

PRIMITIVE man in the tropics looks to the forest for almost all the necessities of life which are not provided by his field crops and domestic animals. From it he obtains materials for his house and furniture, fuel, clothing, lighting, weapons, cordage, medicines, edible fruits, game and birds, and numerous other products which play a part in his daily life. Moreover the forests provide him with a large reserve of fertile land indispensable for his primitive system of agriculture.

The arrival of the white man with his civilising and developing influence at once results in a heavy drain on the forest. Large areas of forest land are cleared for agricultural development, and a demand arises for timber for constructional work, roads, railways, domestic purposes, cases for agricul-

tural products and fuel. Further, white rule, bringing with it the blessings of peace and improved hygiene, stimulates a rapid increase in the native population and proportionate increased activity in native agriculture. The consequence in some parts of the tropics is forest destruction on a grand scale at the hands of native agriculturists practising "shifting cultivation," the only system of agriculture known to them.

The most obvious effect of this drain on the forest is the increasing scarcity in accessible situations of the more valuable timber trees. This in itself may be a serious matter but there are other more subtle effects, and unfortunately these too often do not become apparent until it is too late to remedy the situation by immediate action.

It is perhaps not sufficiently well known that the forests of a country have a decisive influence on its climate, particularly in the matter of rainfall. It may be thought that this influence is negligible in a Colony such as Fiji, consisting of a number of small islands enjoying an "ocean" type of climate; but that forests cannot be destroyed with impunity even on Pacific islands may be judged from Guppy's comparison of the rainfall in Hawaii with that in Fiji. Writing of a visit to Hawaii, he says:—*

"The consequence of unchecked destruction of the forests was in my time becoming only too evident. When I passed through Ookala on the Hamakua Coast at the end of May, 1897, there was a water famine. Water was sold at a quarter of a dollar a bucket, and the allowance for a family was three oilcans a week. . . . Originally forests covered the upland plateaux and mountain slopes of all the islands. Now much of the original forests has been removed and large areas of naked soils and bare rocks remain. The present forest area is about 20 per cent. of the islands, a small fraction of what it was a hundred years ago. It is, however, very satisfactory to learn that American energy is combating this evil. . . . Hawaii owes much to the United States Department of Agriculture. May we in England take the cue in the case of our own Crown Colonies!"

Referring to the climate of Fiji he writes:—

"Fortunately the Fijian Islands have not been long enough occupied by the whites to produce much effect on the rainfall through the destruction of the forests. A significant warning, however, has been given in the vicinity of Levuka. The woods of the hills around the town, as we learn from Mr. Horne, were cut down to prevent them from affording shelter to the unfriendly natives of the interior, the result being to reduce the number of rainy days in a few years from 256 to 149 per annum."

From the above extracts it will be appreciated that deforestation may not only cause a substantial decrease in the total precipitation of rainfall, but may also bring about a variation in its incidence. The effect of such climatic changes on agricultural operations is obvious.

The forests on mountain slopes are of value in another way. The foliage of the trees protects the ground from the mechanical disintegrating effect of heavy rain, and the forest soil below, rich in vegetable matter, acts as a sponge which absorbs the water gradually and gradually releases it. Not until this soil becomes saturated is there danger of serious flooding. A heavy downpour of rain will produce no effect more serious than a slight rise in the level of the rivers, and in periods of drought the rivers will fall gradually, drawing on the reserves of water held in the spongy soil of the

* *Observations of a Naturalist in the Pacific*, Vol. II, H. B. Guppy.

forests. Now compare the situation which occurs when a mountain has been deforested. Then every storm will be the signal for the appearance of innumerable torrents which eat out their course as they flow, often laying bare the naked rock beneath. The main river of the system may be unequal to the sudden strain, and overflowing its banks, flood the lower plains with its silt-charged waters. After the storm the flood will subside as rapidly as it began. In dry periods the river having no reserves of water to draw on may be reduced to a mere trickle or even dry up altogether. Our experiences in February are too fresh in our minds for us to underestimate the disastrous effects on agriculture of frequent and severe floods.

PART II.

The British are historically a race of forest destroyers. The forests of the Homeland have long ago practically disappeared, and in all the big Dominions and Colonies with the exception of India they have been regarded up to quite recent years either as a nuisance to be cleared away with all speed to make way for agricultural and industrial development or as an asset which no amount of exploitation can exhaust. It is a British characteristic to live in the present and let the future look after itself, with the comfortable assurance that when the inevitable crisis does come along we will "muddle through" somehow. The War gave this complacent attitude a rude shock in many directions, and among other matters focussed the attention of statesmen in all parts of the Empire on the results of the past improvident destruction of our timber assets. The need for constructive action was further emphasised by the warnings of high authorities who have been examining the World's resources and consumption of softwoods. Mr. Fraser Storey, of the Forestry Commission, London, after a statistical survey of the position, has stated that a serious shortage in the World's supply of softwoods is likely to occur in about 40 years' time. The gravity of this statement will be appreciated when it is realised that the production of a mature spruce tree may take anything from 70 to 120 years.

India has long been a shining example to the rest of the Empire of the great advantages ensuing to the community from a sound forest administration, and of recent years the Home Country, the big Dominions and the larger Crown Colonies have been taking active steps to put their forest administration on a similar basis.

It will be realised from the above remarks that forest policy has both a national and an Imperial importance. Further, it is of the nature of forestry that its returns are slow, that the individual can very rarely hope to reap what he has sown. A forest policy must have continuity over a very long period of years, more than three generations of men. Experience has shown that the task of framing and carrying out such a policy cannot safely be left to private enterprise. Governments alone have the necessary continuity and ability to take the long view, and are not so prone to the temptation to take an immediate profit at the expense of future generations.

In countries where systematic forest management has been in force for centuries, for example, France, Germany and Switzerland, the forests are a great national asset and yield a substantial nett annual revenue to the State. This is true also of India, whose forest administration dates back a mere sixty years or so.

In the early stages of forest administration, particularly if, as is almost invariably the case, the forests have been exposed for a prolonged period to uncontrolled felling, expenditure will in all probability exceed revenue for a number of years. As in any other form of production a certain amount of

capital must be invested to secure a return. It is therefore desirable that the individual citizen who pays for the service should understand the importance of a forest policy, its aims and, as far as possible, the means whereby it is to be carried out.

In a country such as Fiji, the primary objects of forest management would be as follows:—

- (i) to provide a sustained annual yield of timber and fuel sufficient for all future requirements;
- (ii) to maintain an area of forest sufficient to ensure an adequate rainfall, and to reduce the risks of flooding and erosion by controlling the run-off in mountainous country.

Secondary objects would be to provide catchment areas for local water supplies, and to preserve the amenities of the countryside by protecting beautiful tracts. Anyone who has seen the devastation in the neighbourhood of the Prince's Road near Suva may indeed be inclined to regard this last as of primary rather than secondary importance.

The first need of a Government embarking on a forest policy is to have control of forests or at least afforestable land. To this end permanent forest estates or forest reserves are created. In other tropical countries it has been found that reservation of 25 to 30 per cent. of the total land area is sufficient to ensure that the objects of the policy are realised. Forest reserves may be constituted on land already held by the Crown, or they may be acquired in some other manner.

The great proportion of forest land in a British Crown Colony is usually owned by the natives. In Nigeria, where the natives own their land communally, forest reserves are as a rule acquired by agreement. The natives do not part with their ownership of the land but surrender the management of it to the Government. In return a proportion of the revenue obtained from the forests is paid into native funds. Government have powers to acquire forest reserves compulsorily if it is considered necessary and if the native owners are unwilling to surrender control by agreement. It will be understood that there is difficulty in persuading a primitive people to surrender control of their land for objects which they find hard to understand and with which in any case they have little sympathy, but this antipathy will gradually disappear as the revenue from the reserves under systematic management increases, and as the forests which are not reserved are destroyed.

Selection of the reserves and their subsequent working to obtain the maximum sustained yield can only be undertaken by experts.

PART III.

My survey of the Fiji forests is not yet complete, but it may be of interest to set down some of the impressions which I have received so far. The arrival of the European has not been attended in Fiji by that wholesale clearing of forest lands which is such a marked feature of his advent in other parts of the tropics. European development has been slow and has been more or less confined to areas of low elevation in the coastal districts. The Fijian farmer, though he is a shifting cultivator, has not made any serious inroads into the forest. His population is comparatively small and is not increasing rapidly. In fact, I received the impression in some districts that there was a tendency to migrate from the villages of the hinterland to the coast. In short the greatest destruction of forest has occurred in the lower-lying developed districts at the hands of European, Indian and Chinese settlers. Old residents have informed me that the amount of silt deposited in the channel of the lower Rewa appears to have been increasing of recent

years and there can be no doubt that this is due to increased erosion in the basin of that river consequent on intensive settlement. Elsewhere, so far as my inspection has gone, there does not appear to be any urgent present need of forest conservation with the primary object of stabilising the climate or preventing erosion. At the same time there is not, so far as I am aware, any legal machinery to check extensive deforestation at high altitudes and in view of the irremediable character and possible disastrous consequences to the agricultural community of such action, the situation requires careful watching.

Now let us consider the position from the standpoint of timber supplies.

Our imports of timber for the year 1929 (a more normal year than 1930) consisted of about 10,500 tons of softwoods and 2,000 tons of hardwoods. The out-turn of sawn timber from local mills is estimated to have been about 8,000 tons and of timber cut for other purposes including native consumption and fuel, about 50,000 tons. The total estimated consumption was thus 70,500 tons, of which our own forests provided about 58,000 tons. This reckoning does not take into account imports of wood in a manufactured form, such as furniture, paper, artificial silk, &c.

The wood consumption per caput of a community is an index of its standard of civilisation, and in a new country the increase in consumption over a period of years is also a guide to the rate of development. The present depression has no doubt slowed down consumption considerably, but when normal times return we may expect a steady expansion in the annual consumption, due to European development, increase in population and improvement in the standard of living of the native races.

Fiji is therefore faced with (1) the probability of an increasing internal demand for timber of all kinds, and (2) the prospect in the not too distant future of a shortage in the external supply, particularly of softwoods. In these circumstances it is wise to take stock of our own resources.

Fiji is fortunate in having in her forests woods suitable for almost every purpose. The following are our more important woods classified according to usage:—

Hardwoods.—Buabua, Vesi, Yasi, Sacau, Savai, Vuga.

Medium hardwoods.—Yaka, Bauvudi, Damanu, Rosawa.

Softwoods.—Kauri, Dakua Salusalu.

Casewoods.—Kauvula, Kaudamu.

Fuels.—Dogo, Nokonoko, Caukuro.

Luxury wood.—Sandalwood.

Of the hardwoods, Buabua and Vesi are the most sought after. Both have a limited range, and consumption, particularly of Buabua, probably exceeds production. Sacau and Vuga are mountain trees and not being easily accessible are not much cut. Yasi, of which there are many kinds, is in good supply over most of the forest area. Savai is in fair supply in Vanualevu, less so in Vitilevu.

Of the medium hardwoods, Yaka is at once the most sought after and appears to have the most limited range of any tree in Fiji. It does not regenerate well without assistance, and exhaustion of the more accessible stands of Yaka appears to be a matter of time. Damanu is a common tree in better quality forest throughout the group. Bauvudi, though not so common as Damanu, is in fair supply. Rosawa is rather rare and grows usually at high, not easily accessible elevations.

Of the softwoods, the Kauri has been heavily cut where reasonably accessible. It is widely distributed over the mountain ridges of the islands, and in a few localities it may furnish about 60 per cent. of the millable volume. It does not regenerate well without assistance, but the seedlings

of the tree are fairly hardy when established. *Dakua Salusalu* is less widely distributed than the *Kauri*, and is common only in a few favoured localities. It regenerates freely, but the seedlings are quickly killed by lack of light and pressure of competition. Both these trees yield a timber equal, if not superior to, any imported softwood, provided that due attention is paid to seasoning, a matter which has been too often neglected.

The casewoods, *Kauvula* and *Kaudamu*, are in good supply. There are probably other woods suitable for this trade and the yield of the forest appears to be more than equal to the present demand.

Of the fuels, *Dogo* has been heavily cut in the neighbourhood of Suva, and exhaustion of the big timber of the *Navua* forests is in sight. There is still a large reserve of smaller sized fuel in the *Rewa Delta*. There has not been much exploitation of the other *Dogo* forests. The tree regenerates well and needs little assistance. *Nokonoko* and *Caukuro* are in good supply on the dry side of the islands.

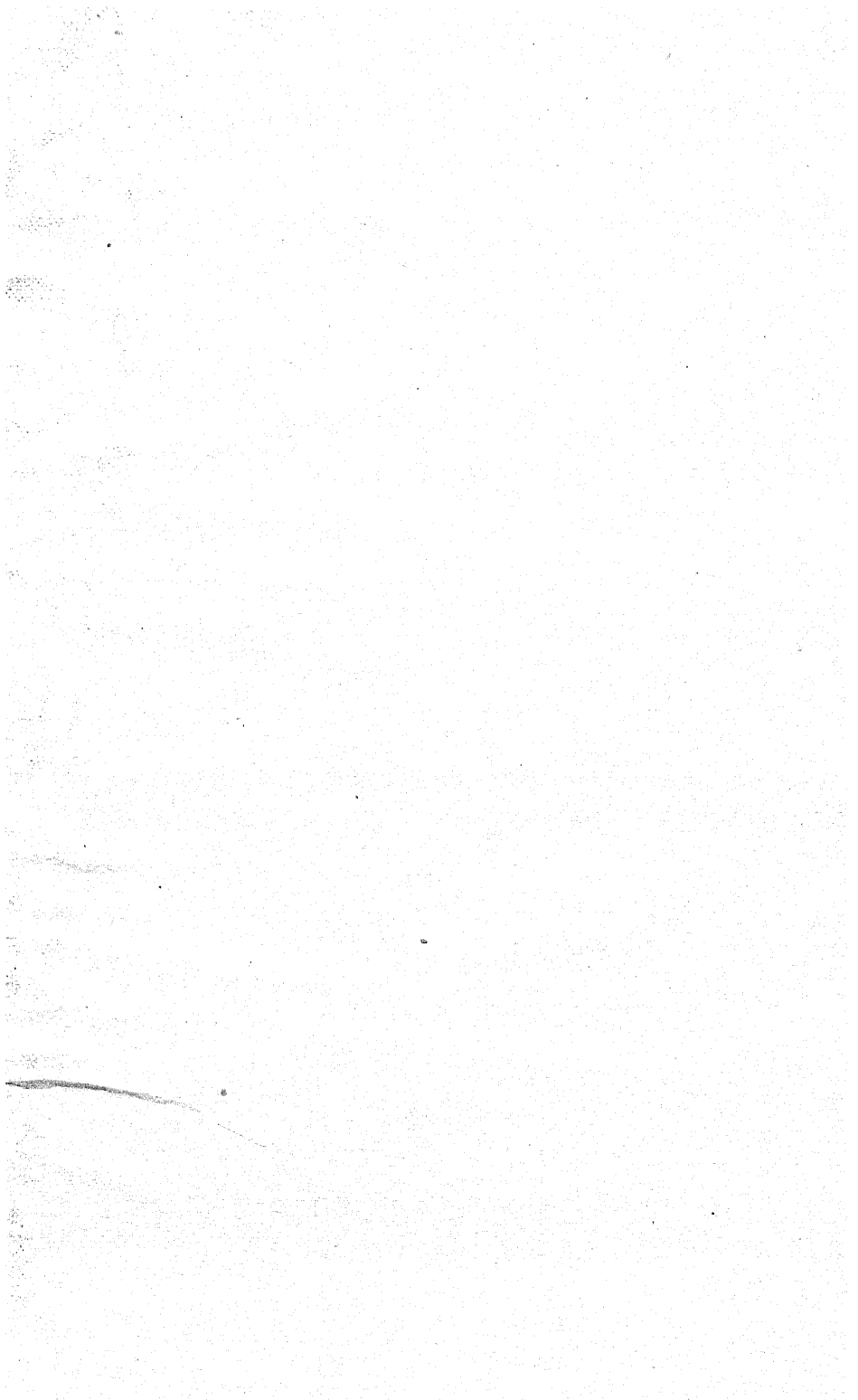
Sandalwood in commercial sizes has practically disappeared, and even young saplings are exceedingly rare. This tree furnishes one of the most valuable woods in the world. *Fiji* has lost a valuable asset by allowing uncontrolled exploitation of her sandalwood forests.

It is a basic principle of forestry that the annual cut should not exceed the forest's capacity of production if the yield is to be maintained. The disappearance of sandalwood is due to non-observance of this principle, and it appears that supplies in accessible situations of *Yaka*, *Kauri*, *Dakua* [*Salusalu*], *Buabua* and possibly *Vesi* are dwindling for the same reason.

The danger with a situation of this sort is that it is not apparent until an acute crisis arises when it is probably too late to take effective remedial action. It is not, for example, expected that warning of the approaching shortage of softwoods will be given by a gradual increase in the prices of these woods. The reason is that the American mills, which hold the key to the position, are planned on the basis of an enormous output. Prices are therefore likely to remain comparatively stationary for some time and rise sharply in a series of jumps as these mills are put out of action one by one owing to failure in the supply.

The forests of *Fiji* are quite equal under scientific management to the task of supplying indefinitely all possible future requirements, and even of providing a balance of our better class woods for export. It is not proposed to describe here in detail the methods by which this desirable end can be accomplished, but it may be briefly indicated that improvement of forest lands is effected mainly through cultural operations designed to increase the numbers of economic species in the forest rather than by clearing and planting. At the present time many of our forests are uneconomical to work on account of the low proportion in them of economic species. Improvement of such forests would present little difficulty to a professional forester.

An active policy of forest development would make productive lands which are at present practically worthless, would improve the internal communications of the Colony, and would provide a number of Europeans and natives with congenial employment. It is realised that it may not be financially possible to embark on such a policy at the present time, but this article will have served its purpose if it has brought to notice a situation which it may be dangerous to neglect.



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